

THE  
WISDOM OF GOD  
Manifested in the  
WORKS  
OF THE  
CREATION:  
In TWO PARTS.

VIZ.

The heavenly BODIES, ELEMENTS, METEORS;  
FOSSILS, VEGETABLES, ANIMALS, (BEASTS,  
BIRDS, FISHES, and INSECTS) more particular-  
ly in the Body of the Earth, its Figure, Moti-  
on, and Consistency; and in the admirable  
Structure of the Bodies of Man and other Ani-  
mals; as also in their Generation, &c. With  
Answers to some Objections.

By JOHN RAY, late FELLOW of the  
ROYAL SOCIETY.

The THIRTEENTH EDITION, Corrected!

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TO THE  
Much honoured and truly religious  
L A D Y  
THE  
Lady LETTICE WENDY,  
OF  
*Wendy in Cambridgeshire.*

MADAM,

**T**WO or three reasons induce me to present this discourse to your ladyship, and to make choice of you for its patroness; *First*, Because I owe it to the liberality of your honoured brother that I have this leisure to write any thing; *Secondly*, Because also your many and signal favours, seeing I am not in a capacity to requite them, seem to exact from me at least a public acknowledgement, which such a dedication gives me an opportunity to make. *Thirdly*, Because of such kind of writings I know not where to chuse a more able judge or more candid reader. I am sensible that you do so much abhor any thing that looks like flattery, that, out of an excess of modesty, you cannot patiently bear the hearing of your own just commendations; and therefore should I enlarge upon that subject, I know I should have but little thanks for my pains.

INDEED you have much better motives to do well than the praise of men, the favour of God, peace of conscience, the hope and expectation of a future reward of *eternal happiness*; and, therefore, I had rather write of you to others, to provoke them to imitate so excellent an example, than to yourself, to encourage you in your christian course, and to fortify you in your athletic conflicts with the greatest of temporal evils, bodily pain and anguish; tho' I do not know why you should reject any consideration that may conduce to support you under so heavy pressures, and of so long continuance; of which, to ingenuous natures, true honour, that is, the current testimony and approbation of good men, is not the meanest. No less a man than St. *Augustine* was doubtful, whether the extremity of bodily pain were not the greatest evil that human nature was capable of suffering: *Nay (saith he) I was sometimes compelled to consent to Cornelius Celsus, that it was so, neither did his reasons seem to me absurd; we being compounded of two parts, Soul and Body, of which the first is the better, the latter the worse; the greatest good must be the best thing belonging to the better part, that is, wisdom; and the greatest evil the worst thing incident to the worst part, (the body) that is pain.* Now tho' I know not whether this reason be firm and conclusive, yet I am of accord with him, that of all the evils we are sensible of in this world, it is the sorest; the most resolute patience being baffled and prostrated by a fierce and lasting paroxysm of the gout, or stone, or cholic, and compelling to *yield to its furious insults*, and confess itself vanquished, the

soul

*The Epistle Dedicatory.*

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soul being unable to divert, or to do any thing else but pore upon pain; and therefore those stoical vaunts of their wise man's being happy in *Phalaris's* bull, I utterly reject and explode, as vain rodmondates and chimerical figments, for that there never was such a wise man among them, or indeed could be; yet do I not say, that the patience of a good man can be so far conquered by the sharpest and severest torments, as to be compelled to deny or blaspheme *God* or his *Religion*; yea, or so much as to complain of injustice; tho' perchance he may be brought with *Job* to curse his day, yet not curse his *God*, as his wife tempted him to do.

Now that great *Αγνοήτης* and *Επαγής*; the most just Judge and Rewarder, would be pleased to qualify and mitigate your sufferings, as not to exceed the *Measure of your Strength and Patience*, or else arm you with such an high degree of christian fortitude, as to be able to grapple with the most extreme; and when you have finished your course in this world, grant you a placid and easy passage out of it, and dignify you as one of his victors, with a crown of eternal glory and felicity, is the prayer of,

MADAM,

Your LADYSHIP's

Most Devoted in all Service;

JOHN RAY.



# THE P R E F A C E.

**I**N all ages wherein learning hath flourished, complaint hath been made of the itch of writing, and the multitude of worthless books, wherewith importunate scriblers have pestered the world: *Scribimus indocti doctique; And---Tenet insana-bile multos scribendi cacoethes.* I am sensible that this tractate may likely incur the censure of a superfluous piece, and myself the blame of giving the reader unnecessary trouble, there having been so much so well written of this subject by the most learned men of our time, Dr. *Mure*, Dr. *Cudworth*, Dr. *Stillingfleet*, late bishop of *Worcester*, Dr. *Parker*, late of *Oxon*; and, to name no more, the honourable *Robert Boyle*, Esq; so that it will need some apology. *First*, Therefore, in excuse of it, I plead, that there are in it some considerations new and untouched by others; wherein, if I be mistaken, I alledge, *Secondly*, That the manner of delivery and expression, may be more suitable to some mens apprehension, and facil to their understandings. If that will not hold, I pretend, *Thirdly*, That all the particulars contained in this book, cannot be found in any one piece known to me, but lie scattered and dispersed in many; and so this may serve to relieve those fastidious readers, that are not willing to take the pains to search them out; and possibly, there may be some whose ability (whatever their industry might be) will not serve them to purchase, nor  
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their opportunity to borrow those books, who yet may spare money enough to buy so inconsiderable a trifle. If none of these excuses suffice to acquit me of blame, and remove all prejudice, I have two further reasons to offer, which I think will reach home, and justify this undertaking. *First*, That all men who presume to write, at least, whose writings the printers will venture to publish, are of some note in the world; and where they do, or have lived and conversed, have some sphere of friends and acquaintance, that know and esteem them, who it is likely will buy any book they shall write for the author's sake, who otherwise would have read none of that subject, tho' ten times better; and so the book, however inferior to what have been already published, may happen to do much good. *Secondly*, By virtue of my function I suspect myself to be obliged to write something in divinity, having written so much on other subjects; for, not being permitted to serve the church with my tongue in preaching, I know not but it may be my duty to serve it with my hand by writing: And I have made choice of this subject, as thinking myself best qualified to treat of it. If what I have now written shall find so favourable acceptance, as to encourage me to proceed, God granting life and health, the reader may expect more; if otherwise, I must be content to be laid aside as useless, and satisfy myself in having made this experiment.

As for this discourse, I have been careful to admit nothing for matter of fact or experiment, but what is undoubtedly true, lest I should build upon a sandy and ruinous foundation; and by the admixture of what is false, render that which is true suspicious.

I might have added many more particulars; nay, my text warrants me to run over all the visible works

works of God in particular, and to trace the footsteps of his wisdom in the composition, order, harmony, and uses of every one of them; as well as of those that I have selected. But, *First*, this would be a task far transcending my skill and abilities; nay, the joint skill and endeavours of all men now living, or that shall live after a thousand ages should the world last so long. *For no man can find out the work that God maketh from the beginning to the end*, Eccl. iii. 11. *Secondly*, I was willing to consult the infirmity of the reader, or indeed of mankind in general; which, after a short confinement to one sort of dish, is apt to loath it, tho' never so wholesome, and which at first was most pleasant and acceptable; and so to moderate my discourse, as to make an end of writing, before I might presume he should be quite tired with reading.

I shall now add a word or two concerning the usefulness of the argument, or matter of this discourse, and the reason I had to make choice of it, besides what I have already offered.

*First*, The belief of a Deity being the foundation of all religion (Religion being nothing but a devout worshipping of God, or an inclination of mind to serve and worship him) *for he that cometh to God, must believe that he is God*; it is a matter of the highest concernment to be firmly settled and established in a full persuasion of this main point; now this must be demonstrated by arguments drawn from the light of nature, and works of the creation; for as all other sciences, so divinity, proves not, but supposes its subjects, taking it for granted, that by natural light, men are sufficiently convinced of the being of a Deity. There are indeed supernatural demonstrations of this fundamental truth, but not common to all persons or times, and so liable to cavil and exception by atheistical persons, as inward illuminations of mind, a spirit of proph-

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cy, and foretelling future contingents, illustrious miracles, and the like: But these proofs, taken from effects and operations, exposed to every man's view, not to be denied or questioned by any, are most effectual to convince all that deny or doubt of it; neither are they only convictive of the greatest and subtlest adversaries, but intelligible also to the meanest capacities; for you may hear illiterate persons, of the lowest rank of the commonalty affirming, that they need no proof of the being of a God, for that every pile of grass, or ear of corn, sufficiently proves that; for, say they, all the men of the world cannot make such a thing as one of these; and if they cannot do it, who can or did make it but God? To tell them, that it made itself, or sprung up by chance, would be as ridiculous as to tell the greatest philosopher so.

*Secondly*, The particulars of this discourse serve not only to demonstrate the being of a Deity, but also to illustrate some of his principal attributes; as, namely, his infinite power and wisdom; the vast multitude of creatures, and those not only small, but immensely great, the sun, and the moon, and all the heavenly host, are effects and proofs of his Almighty power. *The heavens declare the glory of God, and the firmament sheweth his handy-work, Psal. xix. 1.* The admirable contrivance of all and each of them, the adapting all the parts of animals to their several uses, the provision that is made for their sustenance, which is often taken notice of in scripture, *Psal. cxlv. 15, 16. The eyes of all wait upon thee: thou givest them their meat in due season. Thou openest thy hand, and satisfiest the desire of every living thing. Mat. vi. 26. Behold the fowls of the air, for they sow not, neither do they reap, nor gather into barns; yet your heavenly Father feedeth them. Psal. cxlvii. 9. He giveth to the beast his food, and to the young ravens when they cry.* And lastly, their mutual sub-

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fervency to each other, and unanimous conspiring to promote and carry on the public good, are evident demonstrations of his sovereign wisdom.

*Lastly*, They serve to stir up and increase in us the affections and habits of admiration, humility, and gratitude. *Psal. viii. 3. When I consider the heavens, the work of thy fingers, the moon and the stars which thou hast ordained: What is man that thou art mindful of him; or the son of man that thou visitest him?* And to these purposes the holy psalmist is very frequent in the enumeration and consideration of these works, which may warrant me doing the like, and justify the denominating such a discourse as this, rather theological than philosophical.

[Note, *That by the works of the creation, in the Title, I mean the works created by God at first, and by him conserved to this day in the same state and condition in which they were at first made; for conservation (according to the judgment both of philosophers and divines) is a continued creation.*]

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THE  
WISDOM OF GOD  
Manifested in the  
WORKS  
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CREATION:  
PART I.

PSALM civ. 24.

*How manifold are thy Works, O Lord!  
In Wisdom hast thou made them all.*

**I**N these words are two clauses; in the first whereof the Psalmist admires the multitude of God's works, *How manifold are thy works, O Lord!* In the second he celebrates his wisdom in the creation of them; *In Wisdom hast thou made them all.*

Of the first of these I shall say little, only briefly run over the works of this visible world, and give some guess, at the number of them; whence it will appear, That upon this account they will deserve admiration, the number of them being uninvestigable by us, and so affording us a demon-

strative proof of the unlimited extent of the creator's skill, and the fecundity of his wisdom and power. That the number of corporeal creatures is unmeasurably great, and known only to the Creator himself, may thus probably be collected: First of all, The number of fixed stars is on all hands acknowledg'd to be next to infinite: Secondly, every fix'd star, in the now-receiv'd *Hypothesis*, is a sun, or sun-like Body, and in like manner incircled with a *Chorus* of planets moving about it; for the *Fix'd Stars* are not all placed in one and the same concave spherical *Superficies*, and equidistant from us, as they seem to be, but are variously and disorderly situate, some nearer, some further off, just like trees in a wood or Forrest, as *Gassendus* exemplifies them. And as in a wood, though the trees grow never so irregularly, yet the eye of the spectator, wherever plac'd, or whithersoever remov'd, describes still a circle of trees: So would it in like manner whenever it were in the forest of stars, describe a spherical *Superficies* about it. Thirdly, Each of these planets is in all likelihood furnished with as great variety of corporeal creatures, animate and inanimate, as the earth is, and all as different in nature as they are in place from the terrestrial, and from each other. Whence it will follow, That these must be much more infinite than the stars; I do not mean absolutely according to philosophick exactness infinite, but only infinite or innumerable as to us, or their number prodigiously great.

That the fix'd stars are innumerable, may thus be made out: Those visible to the naked eye are by the least account acknowledg'd to be above a thousand, excluding those towards the *South* pole, which are not visible in our horizon: Besides these, there have been incomparably more detected and brought to light by the telescopes; the milkway

be.

being found to be (as was formerly conjectur'd) nothing but great companies or swarms of minute stars singly invisible, but by reason of their proximity mingling and confounding their lights, and appearing like lucid clōuds. And it is likely that, had we more perfect telescopes, many thousands more might be discovered; and yet, after all, an incredible multitude remain, by reason of their immense distance beyond all ken, by the best telescopes that could possibly be invented or polish'd by the wit and hand of an angel: For if the world be (as *Des Cartes* would have it) indefinitely extended, that is, so far as no human intellect can fancy any bound of it; then what we see, or can come to see, must be the least part of what is undiscoverable by us, the whole universe extending a thousand times farther beyond the utmost stars we can possibly descry, than those be distant from the earth we live upon. This *Hypothesis* of the *Fix'd Stars* being so many *Suns*, &c. seems more agreeable to the divine greatness and magnificence. But that which induces me much to doubt of the magnitude of the Universe, and immense distance of the *Fix'd Stars*, is the stupendous *Phænomena* of *Comets*, their sudden accession, or appearance in full magnitude, the length of their tails, and swiftness of their motion, and gradual diminution of bulk and motion, till at last they disappear. That the universe is indefinitely extended, *Des Cartes*, upon a false ground, (that the *formal Ratio* of a body was nothing but extension into length, breadth, and profundity, or having *partes extra partes*, and that *Body* and *Space* were synonymous terms) asserted; it may as well be limited this way, as in the old *Hypothesis*, which places the *Fix'd Stars* in the spherical *Superficies*; according to which (old *Hypothesis*) they may also be demonstrated by the same *Medi-*



ums to be innumerable, only instead of their distance substituting their smallness for the reason of their invisibility.

But leaving the *Cœlestial* bodies, I now come to the *Terrestrial*: which are either *inanimate*, or *animate*. The *inanimate* are the *Elements*, *Meteors*, and *Fossils* of all sorts, at the number of which last I cannot give any probable guess: But if the rule, which some considerate philosophers deliver, holds good, *viz.* how much more imperfect any *Genus*, or order of beings, is, so much more numerous are the *Species* contain'd under it. As for example: Birds being a more perfect kind of animals than fishes, there are more of these than of those; and for the like reason more Birds than Quadrupeds, and more insects than of any of the rest, and so more plants than animals, nature being more sparing in her more excellent productions. If this rule, I say, holds good, then should there be more *Species* of *Fossils*, or generally of *inanimate Bodies*, than of *Vegetables*, of which there is some reason to doubt, unless we will admit all sorts of formed stones to be distinct *Species*.

Animate bodies are divided into four great *Genera*, or orders, *Beasts*, *Birds*, *Fishes*, and *Insects*.

The *Species* of *Beasts*, including also *Serpents*, are not very numerous: Of such as are certainly known and describ'd, I dare not say above 150; and yet I believe, not many, that are of any considerable bigness, in the known regions of the world, have escap'd the cognizance of the curious. (I reckon all *Dogs* to be of one *Species*, they mingling together in generation, and the breed of such mixtures being prolifick.)

The number of *Birds* known and describ'd may be near 500; and the number of *Fishes*, secluding *Shell-fish*, as many: But if the *Shell-fish* be taken in, more than six times the number. How many of each



each *Genus* remain yet undiscover'd, one cannot certainly nor very nearly conjecture; but we may suppose the whole sum of *Beasts* and *Birds* to exceed by a third part, and *Fishes* by one half, those known.

The *Insects*, if we take in the *Exanguious* both *Terrestrial* and *Aquatick*, may in derogation to the precedent rule, for number, vie even with *Plants* themselves: For the *Exanguious* alone, by what that learned and critical naturalist, my honour'd friend, Dr. *Martin Lister*, hath already observ'd and delineated, I conjecture, cannot be fewer than 3000 *Species*, perhaps many more.

The *Butterflies* or *Beetles* are such numerous tribes, that I believe in our own native country alone the *Species* of each kind may amount to 150 or more. And if we should make the *Caterpillers* and *Hexapods*, from whence these come, to be distinct *Species*, as most naturalists have done, the number will be doubled, and these two *Genera* will afford us 600 *Species*; But if those be admitted for distinct *Species*, I see no reason but their *Aureliæ* also may pretend to a specifick difference from the *Caterpillers* and *Butterflies*, and so we shall have 300 *Species* more; therefore we exclude both these from the degree of *Species*, making them to be the same *Insect* under a different *Larva* or habit.

The *Fly-kind*, if under that name we comprehend all other flying *Insects*, as well such as have four, as such as have but two wings, of both which kinds there are many subordinate *Genera*, will be found in multitude of *Species* to equal, if not exceed, both the foremention'd kinds.

The *creeping Insects* that never come to be wing'd, tho' for number they may fall short of the flying or winged, yet are they also very numerous; as by running over the several kinds I could easily demonstrate. Supposing then there be a thousand several sorts of *Insects* in this island and

the sea near it, if the same proportion holds between the Insects native in *England*, and those of the rest of the world, as doth between plants *domestick* and *exotick*, (that is, as I guess, near a decuple) the Species of *Insects* in the whole earth (land and water) will amount to 10000, and I do believe they rather exceed than fall short of that sum. Since the writing hereof, having this summer, *Anno. 1691*, with some diligence prosecuted the history of our *English* Insects, and making collections of the several Species of each tribe, but particularly and especially of the *Butterflies*, both nocturnal and diurnal, I find the number of such of these alone as breed in our neighbourhood (about *Braintree* and *Notely* in *Essex*) to exceed the sum I last year assign'd to all *England*, having myself observ'd and describ'd about 200 kinds great and small, many yet remaining, as I have good reason to believe, by me undiscover'd. This I have, since the writing hereof, found true in experience, having every year observ'd, not a few new kinds: Nor do I think that, if I should live 20 years longer, I should by my utmost diligence and industry in searching them out, come to an end of them. If then, within the small compass of a mile or two, there are so many Species to be found, surely the most modest conjecture cannot estimate the number of all the kinds of *Papilio's* native of this Island to fall short of 300, which is twice so many as I last summer guess'd them to be; wherefore, using the same argumentations, the number of all the *British* Insects will amount to 2000, and the total sum of those of the whole earth will be 20000. The number of the plants contain'd in *C. Bauhin's Penax* is about 6000, which are all that had been describ'd by the authors that wrote before him, or observ'd by himself; in which works, besides mistakes and repetitions incident to the most wary and

and knowing men in such a work as that, there are a great many, I might say some hundreds, put down for different Species, which in my opinion are but accidental varieties: Which I do not say to detract from the excellent pains and performance of that learned, judicious and laborious Herbarist, or to defraud him of his deserv'd honour, but only to shew that he was too much sway'd by the opinions then generally current among Herbarists, that different colour or multiplicity of leaves in the flower, and the like accidents, were sufficient to constitute a specifick difference. But supposing there had been 6000 then known and describ'd, I cannot think but there are in the world more than triple that number; there being in the vast continent of *America* as great a variety of *Species* as with us, and yet but few common to *Europe*, or perhaps *Africk* and *Asia*. And if, on the other side the Equator, there be much land still remaining undiscover'd, as probably there may, we must suppose the number of plants to be far greater.

What can we infer from all this? If the number of creatures be so exceeding great, how great, nay immense, must needs be the power and wisdom of him who form'd them all! For (that I may borrow the words of a noble and excellent author) as it argues and manifests more skill by far in an artificer, to be able to frame both *clocks* and *watches*, and *pumps*, and *mills*, and *granadises*, and *rockets*, than he could display in making but one of those sorts of engines; so the Almighty discovers more of his wisdom in forming such a vast multitude of different sorts of creatures, and all with admirable and irreproveable art, than if he had created but a few; for this declares the greatness and unbounded capacity of his understanding. Again, the same superiority of knowledge would be display'd, by contriving engines of the same kind,  
or



or for the same purposes, after different fashions, as the moving of clocks or other engines by springs instead of weights: So the infinitely wise Creator hath shewn in many instances, that he is not confin'd to one only instrument for the working one effect, but can perform the same thing by divers means. So, tho' feathers seem necessary for flying, yet hath he enabled several creatures to fly without them, as two sorts of fishes, one sort of Lizard, and the Batt, not to mention the numerous tribes of flying Insects. In like manner, though the air-bladder in fishes seems necessary for swimming, yet some are so form'd as to swim without it, *viz.* First, the *Cartilagineous* kind, which by what artifice they poize themselves, ascend and descend at pleasure, and continue in what depth of water they list, is as yet unknown to us. Secondly, the *Cetaceous* kind, or sea-beasts, differing in nothing almost from Quadrupeds but the want of feet. The air which in respiration these receive into their lungs, may serve to render their bodies equi-ponderant to the water; and the constriction or dilatation of it, by the help of the diaphragm and muscles of respiration, may probably assist them to ascend or descend in the water, by a light impulse thereof with their fins.

Again, Tho' the water being a cold element, the most wise God hath so attemper'd the blood and bodies of fishes in general, that a small degree of heat is sufficient to preserve their due consistency and motion, and to maintain life; yet to shew that he can preserve a creature in the sea, and in the coldest part of the sea too, that may have as great a degree of heat as Quadrupeds themselves, he hath created variety of these *cetaceous* fishes, which converse chiefly in the Northern seas whose whole body being incompass'd round with a copious fat or blubber (which, by reflecting and

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redoubling the internal heat, and keeping off the external cold, doth the same thing to them that cloaths do to us) is enabled to abide the greatest cold of the sea-water. The reason why these *fishes* delight to frequent chiefly the *Northern* seas, is, I conceive, not only for the quiet which they enjoy there, but because the *Northern* air, which they breathe in, being more fully charg'd with those particles suppos'd nitrous, which are the element of fire, is fittest to maintain the vital heat in that activity which is sufficient to move such an unweildy bulk as their bodies are with due celerity, and to bear up against and repel the ambient cold; and may likewise enable them to continue longer under water than a warmer and thinner air could.

Another instance to prove that God can and doth by different means produce the same effect, is the various ways of extracting the nutritious juice out of the aliment, in several kinds of creatures.

1. In *Man* and *viviparous Quadrupeds* the food moisten'd with the spittle (*saliva*) is first chew'd and prepared in the mouth, then swallowed into the stomach, where being mingled with some dissolvent juices, it is by the heat hereof concocted, macerated, and reduc'd into a chyle or cremor, and so evacuated into the intestines, where being mixed with the choler and *Pancreatick* juice, it is further subtiliz'd and render'd so fluid and penetrant, that the thinner and finer part of it easily finds its way in at the streight orifices of the lacteous veins.

2. In *Birds* there is no mastication or comminution of meat in the mouth; but in such as are not carniverous, it is immediately swallow'd into the crop or craw, or at least into a kind of antestomach (which I have observ'd in many, especially in *Piscivorous Birds*) where it is moistned and molified by some proper juice from the Glandules distilling

stilling in there, and thence transfer'd into the Gizard or musculous stomach, whereby the working of the muscles compounding the side of that ventricle, and by the assistance of small Pebbles (which the creature swallows for that purpose) it is, as it were by mill-stones, ground small, and so transmitted to the guts, to be further attenuated and subtiliz'd by the fore-mentioned Choler and Pancreatick Juice.

3. In *oviparous Quadrupeds*, as *Chamelions*, *Lizards*, *Frogs*, as also in all sorts of *Serpents*, there is no mastication or comminution of the meat either in mouth or stomach; but as they swallow *Insects* or other Animals whole, so they avoid their skins unbroken, having a heat, or spirits, powerful enough to extract the juice they have need of, without breaking that which contains it; as the *Parisian Academists* tell us. I myself cannot warrant the truth of the observation in all. Here, by the by, we take notice of the wonderful Dilatibility or extensiveness of the throats and gullets of *Serpents*: I myself have taken two entire adult *Mice* out of the stomach of an *Adder*, whose neck was not bigger than my little finger. These creatures, I say, draw out the juice of what they swallow without any comminution, or so much as breaking the skin; even as it is seen that the juice

\*Whole Grapes pluck'd  
from the Cluster, and  
Wine pour'd upon them  
in a Vessel.

of grapes is drawn as well from the \* Rape, where they remain whole, as from a vat, where they are bruis'd; to borrow the *Parisian* philosophers similitude.

4. *Fishes*, which neither chew their meat in their mouths, nor grind it in their stomachs, do by the help of a dissolvent liquor, there by nature provided, corrode, and reduce it, skin, bones and all, into a *Chylus* or *Cremor*; and yet (which may seem wonderful) this liquor, manifests no-

thing



thing of acidity to the taste : But notwithstanding, how mild and gentle soever it seems to be, it corrodes flesh very strangely and gradually, as *Aquafortis*, or the like corrosive waters, do metals, as appears to the Eye ; for I have observed fish in the stomachs of others thus partially corroded, first the superficial part of the flesh, and then deeper and deeper by degrees to the bones.

I come now to the second part of the words, *In wisdom hast thou made them all*; in discoursing whereof I shall endeavour to make out in particulars what the *Psalmist* here asserts in general concerning the works of God, that they are all very wisely contrived and adapted to ends both particular and general.

But before I enter upon this task, I shall, by way of *Preface*, or *Introduction*, say something concerning those systems which undertake to give an account of the formation of the universe by Mechanical *Hypotheses* of matter, mov'd either uncertainly, or according to some Catholick laws, without the intervention and assistance of any superior immaterial agent.

There is no greater, at least no more palpable and convincing argument of the Existence of a Deity, than the admirable art and wisdom that discovers itself in the make and constitution, the order and disposition, the ends and uses of all the parts and members of this stately fabrick of Heaven and earth : For if in the works of art (as for example) a curious edifice, or Machine, council, design, and direction, to an end appearing in the whole frame, and in all the several pieces of it, do necessarily infer the being and operation of some intelligent architect, or engineer ; why should not also, in the works of nature, that grandeur and magnificence, that excellent contrivance for beauty, order, use, &c. which

which is observable in them, wherein they do as much transcend the effects of human art, as infinite power and wisdom exceeds finite, infer the existence and efficiency of an omnipotent and allwise Creator ?

To evade the force of this argument, and to give some account of the original of the world, Atheistical persons have set up two *Hypotheses*.

The first is that of *Aristotle*, that the world was from eternity in the same condition that now it is, having run through the successions of infinite generations: to which they add, self-existent and unproduc'd: For *Aristotle* doth not deny God to be the *efficient cause* of the world; but only asserts, that he created it from eternity, making him a necessary cause thereof; it proceeding from him by way of emanation, as light from the Sun.

This *Hypothesis*, which hath some shew of reason, for something must necessarily exist of itself; and if something, why may not all things? This *Hypothesis*, I say, is so clearly and fully confuted by the Rev. and learned Dr. *Tillotson*, late lord Archbishop of *Canterbury*, and Primate of all *England*, in his first printed sermon; and the right Reverend Father in God, *John*, late lord Bishop of *Chester*, in book I. Chap. V. of his treatise of the *Principles of Natural Religion*, that nothing material can by me be added: To whom therefore I refer the reader

#### *The Epicurean Hypothesis rejected.*

The second *Hypothesis* is that of the *Epicureans*, who held, that there were two principles self-existent. First, *Space*, or *Vacuity*; Secondly, *Matter*, or *Body*; both of infinite duration and extension. In this infinite space, or vacuity, which hath neither beginning, nor end, nor middle

dle, no limits, or extreams, innumerable minute bodies, into which the matter was divided, call'd *Atoms*, because by reason of their perfect solidity they were really indivisible, for they hold no body capable of division, but what have vacuities interspers'd with matter, of various but a determinate number of figures, and equally ponderous, do perpendicularly descend, and by their fortuitous concurrence make compound bodies, and at last the world itself. But now, because if all these atoms should descend plum down with equal velocity, as according to their doctrine they ought to do, being (as we said) all perfectly solid and imporous, and the *Vacuum* not resisting their motion, they would never the one overtake the other, but like the drops of a shower would always keep the same distances, and so there could be no concurrence, or cohaesion of them, and consequently nothing created; partly to avoid this destructive consequence, and partly to give some account of the freedom of will (which they did assert contrary to the *Democratick* fate) they did absurdly feign a declination of some of these principles, without any shadow, or pretence of reason. The former of these motives you have set down by *Lucretius de Nat. Rerum*, L. 2. in these words:

*Corpora cum deorsum rectum per inane feruntur,  
Ponderibus propriis, incerto tempore forte,  
Incertisque locis, spatio discedere paulum;  
Tantum quod nomen mutatum dicere possis.*

And again,

*Quod nisi declinare solerent, omnia deorsum  
Inbris uti guttæ caderent per inane profundum,  
Nec foret offensus natus, nec plaga creata  
Principiis, ita nil unquam natura creasset.*



Now seeds in downward motion must decline,  
 Tho' very little from th' exactest line ;  
 For did they still move strait, they needs must fall  
 Like drops of rain, dissolv'd and scatter'd all,  
 For ever tumbling thro' the mighty space,  
 And never join to make one single mass.

The second motive they had to introduce this gratuitous declination of atoms, the same Poet gives us in these verses, *Lib. 2.*

— *Si semper motus connectitur omnis,  
 Et vetere exoritur semper novus ordine certo ;  
 Nec declinando faciunt primordia motus  
 Principium quoddam quod fati fœdera rumpat,  
 Ex infinito ne causam causa sequatur ;  
 Libra per terras unde hæc animantibus, extat,  
 Unde hæc est, inquam, fatis avolsa voluntas ?*

Besides, did all things move in direct line,  
 And still one motion to another join, }  
 In certain order, and no seeds decline,  
 And make a motion fit to dissipate  
 The well-wrought chains of causes and strong fate;  
 Whence comes that freedom living creatures find?  
 Whence comes the will so free, so unconfin'd,  
 Above the power of fate ?

The folly and unreasonableness of this ridiculous and ungrounded figment, I cannot better display and reprove than in the words of *Cicero*, in the beginning of his first book *De Finibus Bonorum & Malorum*. This declination (saith he) is altogether childishly feign'd, and ye neither doth it at all solve the difficulty, or effect what they desire ; For, first, They say the atoms decline, and yet assign no reason why. Now nothing is more shameful  
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and unworthy a natural philosopher [*turpius Physico*] than to assert any thing to be done without a cause, or to give no reason of it. Besides, this is contrary to their own *Hypothesis* taken from sense, that all weights do naturally move perpendicularly downwards. Secondly, Again supposing this were true, and that there were such a declination of atoms, yet will it not effect what they intend; for either they do all decline, and so there will be no more concurrence than if they did perpendicularly descend; or some decline, and some fall plumb down, which is ridiculously to assign distinct offices and tasks to the atoms, which are all of the same nature and solidity. Again, in his book *De Fato*, he smartly derides this fond conceit thus; what cause is there in nature which turns the Atoms aside? Or do they cast lots among themselves which shall decline, which not? Or why do they decline the least interval that may be, and not a greater? why not two or three *minima* as well as one? *Optare hoc quidem est non disputare.* For neither is the Atom by any extrinsical impulse diverted from its natural course; neither can there be any cause imagin'd in the vacuity thro' which it is carried, why it should not move directly; neither is there any change made in the Atom itself, that it should not retain the motion natural to it, by force of its weight or gravity.

As for the whole *Atomical Hypothesis*, either *Epicurean* or *Democritick*, I shall not, nor need I, spend time to confute it; this having been already solidly and sufficiently done by many learned men, but especially Dr. *Cudworth*, in his *Intellectual System of the Universe*, and the late bishop of Worcester, Dr. *Stillingfleet*, in his *Origines Sacrae*. Only I cannot omit the *Ciceronian* confutation thereof, which I find in the place first quoted, and in the first and second books *De Natura Deorum*,

because it may serve as a general introduction to the following particulars. Such a turbulent concourse of Atoms could never, (saith he) *hunc mundi ornatum efficere*, compose so well-order'd and beautiful a structure as the *world*; which therefore both in *Greek* and *Latin* hath from thence [*ab ornatu & munditie*] obtain'd its name. And again most fully and appositely in his second *De Nat. Deorum*: If the works of *nature* are better, more exact and perfect, than the works of *art*, and *art* effects nothing without reason, neither can the work of *nature* be thought to be effected without reason; for, is it not absurd and incongruous, that when thou beholdest a statue or curious picture, thou should'st acknowledge that art was us'd to the making of it; or when thou seest the course of a ship upon the waters, thou shouldst not doubt but the motion of it is regulated and directed by reason and art; or when thou considerest a sun-dial or clock, thou shouldst understand presently, that the hours are shown by art, and not by chance; and yet imagine or believe, that the world, which comprehends all these arts and artificers, was made without counsel or reason? If one should carry into *Scythia* or *Britain* such a sphere as our friend *Possidonius* lately made, each of whose conversions did the same thing in the *Sun*, and *Moon*, and other five *planets*, which we see effected every night and day in the heavens, who among those Barbarians would doubt that that sphere was compos'd by reason and art? A wonder then it must needs be, that there should be any man found so stupid and forsaken of reason, as to persuade himself, that this most beautiful and adorn'd world, was, or could, be produced by the fortuitous concourse of Atoms. He that can prevail with himself to believe this, I do not see why he may not as well admit, that if there were made innumerable figures



figures of the one and twenty letters, in gold, suppose, or any other metal, and these well shaken and mixt together, and thrown down from some high place to the ground, they, when they light-ed upon the earth, would be so dispos'd and rank'd that a man might see and read in them *Ennius's Annals*; whereas it were a great chance if he should find one verse thereof among them all: For if this concurrence of atoms could make a whole world, why may it not sometimes make, and why hath it not somewhere or other in the earth made, a temple, or a gallery, or a *Portico*, or a house, or a city? which yet it is so far from doing, and every man so far from believing, that should any one of us be cast, suppose, upon a desolate *Island*, and find there a magnificent palace, artificially contriv'd according to the exactest rules of architecture, and curiously adorn'd and furnish'd, it would never once enter into his head, that this was done by an earthquake, or the fortuitous shuffling together of its component materials; or that it had stood there ever since the construction of the *world*, or first cohaesion of *atoms*; but would presently conclude, that there had been some intelligent architect there, the effect of whose art and skill it was. Or should he find there but one single sheet of parchment or paper, an epistle or oration written, full of profound sense, express'd in proper and significant words, illustrated and adorn'd with elegant phrase; it were beyond the possibility of the wit of man to persuade him that this was done by the temerarious dashes of an unguided pen, or by the rude scattering of ink upon the paper, or by the lucky projection of so many letters at all adventures; but he would be convinced by the evidence of the thing at first sight, that there had been not only some man, but some scholar there.

*The Cartesian Hypothesis consider'd and censur'd.*

Having rejected this *Atheistick Hypothesis* of *Epicurus* and *Democritus*, I should now proceed to give particular instances of the art and wisdom clearly appearing in the several parts and members of the universe; from which we may justly infer this general conclusion of the Psalmist, *In wisdom hast thou made them all*: But that there is a sort of professed *Theists*, I mean *Monf. Des Cartes*, and his followers, who endeavour to disarm us of his decretory weapon to evacuate and exterminate this argument, which hath been so successful in all ages to demonstrate the existence, and enforce the belief of a deity, and to convince and silence all atheistick gainsayers. And this they do,

First, By excluding and banishing all consideration of final causes from natural philosophy, upon pretence, that they are all and every one in particular undiscoverable by us; and that it is rashness and arrogance in us to think we can find out God's end, and be partakers of his councils. *Atque ob hanc unicam rationem, totum illud causarum genus quod a fine peti solet, in rebus physicis nullum usum habere existimo; non enim absque temeritate me puto investigare posses fines Dei. Med. Metaph. And for this only reason, I think, all that kind of causes which is wont to be taken from the end, to have no use in physics or natural matters; for I cannot without rashness think my self able to find out the ends of God. And again, in his principles of philosophy; Nullas unquam rationes circa res naturales, a fine quem Deus aut natura in iis faciendis sibi proposuit, admittimus, quia non tantum nobis debemus arrogare ut ejus conciliorum participes esse possimus. We can by no means admit any reasons about natural things, taken from the end which*  
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God or nature purpos'd to themselves in making of them; because we ought not to arrogate so much to ourselves, as to think we may be partakers of his counsels. And more expressly in his fourth answer, viz. to Gassendus's objections; *Nec fingi potest, aliquos Dei fines magis quam alios in propatulo esse; omnes enim imperscrutabili ejus sapientiæ abyssis sunt eodem modo reconditi*; That is, Neither can nor ought we to feign or imagine that some of God's ends are more manifest than others; for all lie in like manner, or equally hidden, in the unsearchable abyss of his wisdom.

This confident assertion of Des Cartes is fully examin'd and reprov'd by that honourable and excellent person, Mr. Boyle, in his *Disquisition about the final Causes of natural Things*, Sect. 1. from page 10. to the end; and therefore I shall not need say much to it, only in brief this, that it seems to me false and of evil consequence, as being derogatory from the glory of God, and destructive of the acknowledgment and belief of a Deity.

For first, Seeing (for instance) that the eye is employ'd by man and all animals for the use of vision, which, as they are fram'd, is so necessary for them, that they could not live without it; and God Almighty knew that it would be so; and seeing it is so admirably fitted and adapted to this use, that all the *wit* and *art* of men and angels could not have contriv'd it better, if so well; it must needs be highly absurd and unreasonable to affirm, either that it was not design'd at all for this use, or that it is impossible for man to know whether it was or not.

Secondly, How can man give thanks and praise to God for the use of his limbs and senses, and those his good creatures which serve for his sustenance, when he cannot be sure they were made in any respect for him; nay, when 'tis as likely they were



were not, and that he doth but abuse them to serve ends for which they were never intended?

Thirdly, This opinion, as I hinted before, supercedes and cassates the best *Medium* we have to demonstrate the being of a Deity, leaving us no other demonstrative proof but that taken from the innate *Idea*: which, if it be a demonstration, is but an obscure one, not satisfying many of the learned themselves, and being too subtle and metaphysical to be apprehended by vulgar capacities, and consequently of no force to persuade and convince them.

Secondly, They endeavour to evacuate and disannul our great argument, by pretending to solve all the *Phenomena* of nature, and to give an account of the production and efformation of the universe, and all the corporeal beings therein, both celestial and terrestrial, as well animate as inanimate, not excluding animals themselves, by a slight *Hypothesis* of matter so and so divided and moved. The *Hypothesis* you have in *Des Cartes's principles of philosophy*, Part 2. *All the matter of this visible world is by him suppos'd to have been at first divided by God into parts nearly equal to each other, of a mean size, viz. about the bigness of those whereof the heavenly bodies are now compounded; all together having as much motion as is now found in the world; and these to have been equally mov'd severally every one by it self about its own centre, and among one another, so as to compose a fluid body; and also many of them jointly, as in company, about several other points so far distant from one another, and in the same manner dispos'd as the centers of the fix'd stars now are.* So that God had no more to do than to create the matter, divide it into parts, and put it into motion, according to some few laws, and that would of it self produce the world, and all creatures therein.

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For a confutation of this *Hypothesis*, I might refer the Reader to Dr. *Cudworth's* System p. 603, 604. but for his ease I will transcribe the words: —God, in the mean time, standing by as an idle spectator of this *Lucus Atomorum*, 'this sportful dance of *Atoms*, and of the various results thereof. Nay, these *mechanick Theists* have here quite outstripp'd and outdone the *Atomick Theists* themselves, they being much more extravagant than ever those were; for the professed *Atheists* durst never venture to affirm, that this regular *System* of things resulted from the *fortuitous Motions* of *Atoms* at the very first, before they had for a long time together produced many other *inept combinations*, or *aggregate forms* of particular things, and *nonsensical systems* of the whole; and they suppos'd also, that the *regularity* of things here in this world would not always continue such neither, but that some time or other, confusion and disorder will break in again. Moreover, that besides this world of ours, there are at this very instant innumerable other worlds *irregular*, and that there is but one of a thousand, or ten thousand among the infinite worlds that have such regularity in them; the reason of all which is, because it was generally taken for granted, and look'd upon as a common notion, that τὼν ἀπὸ τύχης ἢ τῷ αὐτομάτῳ οὐδὲν ἀεὶ οὕτω γίνεσθαι, as *Aristotle* expresseth it; 'none of those things which are from fortune, or chance, come to pass always alike.' But our *mechanick Theists* will have their *Atoms* never so much as once to have fumbled in these their motions, nor to have produc'd any inept system, or incongruous forms at all, but from the very first all along to have taken up their places, and ranged themselves so orderly, methodically and directly, as that they could not possibly have done it better had they been directed by the most perfect wisdom. Wherefore these *Atomick Theists*

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*Theists* utterly evacuate that grand argument for a God taken from the *Phænomenon* of the artificial frame of things, which hath been so much insisted upon in all ages, and which commonly makes the strongest impression of any other upon the minds of men, &c. the *Atheists*, in the mean time, laughing in their *sleeves*, and not a little triumphing to see the cause of *Theism* thus betray'd by its profess'd friends and asserters, and the grand argument for the same totally slurr'd by them, and so their work done, as it were, to their hands.

Now as this argues the greatest insensibility of mind, or sottishness and stupidity in pretended *Theists*, not to take the least notice of the regular and artificial frame of things, or of the signatures of the divine art and wisdom in them, nor to look upon the *world* and *things of nature* with any other eyes than oxen and horses do; so are there many *Phænomena's* in nature, which being partly above the force of these *mechanick powers*, and partly contrary to the same, can therefore never be solv'd by them, nor without *final causes*, and some *vital principles*: As for example, that of gravity, or the tendency of bodies downward, the motion of the *diaphragm* in respiration, the *systole* and *diastole* of the heart, which is nothing but a muscular constriction and relaxation, and therefore not *mechanical* but *vital*. We might also add, among many others, the interfection of the planes of the *equator* and *ecliptick*, or the earth's diurnal motion upon an *axis* not parallel to that of the *ecliptick*, nor perpendicular to the plane thereof: For tho' *Des Cartes* would need imagine this earth of ours once to have been a sun, and so it self the centre of a lesser *vortex*, whose *axis* was then directed after this manner, and which therefore still kept the same site or posture, by reason of the strait particles finding no fit pores,



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or traces, for their passages thro' it, but only in this direction; yet does he himself confess, that because these two motions of the earth, the annual and diurnal, would be much more conveniently made upon parallel *axes*, therefore, according to the laws of Mechanism, they should be perpetually brought nearer together, till at length the *Equator* and *Ecliptick* come to have their *axes* parallel, which, as it hath not yet come to pass, so neither hath there been for these last two thousand years (according to the best observations and judgments of Astronomers) any nearer approach made of them one to another. Wherefore the continuation of these two motions of the earth, the annual and diurnal, upon *axes* not parallel, is resolvable into nothing but a *final* and *mental* cause, or the *τὸ Βέλτιστον* because it was best it should be so, the variety of the seasons of the year depending thereupon. But the greatest of all the particular *Phænomena*, is the formation and organization of the bodies of animals, consisting of such variety and curiosity, that these mechanick philosophers being no way able to give an account thereof from the necessary motion of matter, *unguided by mind for ends*, prudently therefore break off their system there, when they should come to animals, and so leave it altogether untouch'd. We acknowledge indeed there is a *Posthumous* piece extant, imputed to *Cartes*, and entitled, *De la Formation du Fœtus*, wherein there is some pretence made to solve all this fortuitous Mechanism. But as the theory thereof is built wholly upon a false supposition, sufficiently confuted by our *Harvey*, in his book of *Generation*, That the seed doth materially enter into the composition of the egg; so is it all along precarious and exceptionable: nor doth it extend at all to differences that are in several *animals*, nor offer the least reason why an *animal* of one *species* might not

not be form'd out of the seed of another. Thus far the *doctor*, with whom for the main I do consent. I shall only add, that natural philosophers, when they endeavour to give an account of any of the works of nature, by preconceiv'd principles of their own, are for the most part grossly mistaken, and confuted by experience; as *Des Cartes* in a matter that lay before him, obvious to sense, and infinitely more easy to find out the cause of it, than to give an account of the formation of the world; that is, the pulse of the heart, which he attributes to an ebullition and sudden expansion of the blood, in its ventricles, after the manner of the milk, which being heated to such a degree, doth suddenly, and as it were all at once, flush up and run over the vessel. Whether this ebullition be caused by a nitro-sulphureous ferment lodg'd especially in the left ventricle of the heart, which mingling with the blood, excites such an ebullition, as we see made by the mixture of some chymical liquors, *viz.* Oil of vitriol, and deliquated salt of tartar; or, by the vital flame warming and boiling the blood. But this conceit of his is contrary both to reason and experience: For first, it is altogether unreasonable to imagine and affirm that the cool venal blood should be heated to so high a degree in so short a time as the interval of two pulses, which is less than the sixth part of a minute. Secondly, In cold animals, as for example, *Eels*, the heart will beat for many hours after it is taken out of the body, yea, tho' the ventricle be open'd, and all the blood squeez'd out. Thirdly, The process of the fibres which compound the sides of the ventricles running in spiral lines from the tip to the base of the heart, some one way, and some the contrary, do clearly shew that the *Systole* of the heart is nothing but a muscular constriction, as a purse is shut by drawing the strings contrary-ways;

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ways; which is also confirm'd by experience: For if the *vertex* of the heart be cut off, and a finger thrust up into one of the ventricles, in every *systole* the finger will be sensibly and manifestly pinch'd by the sides of the ventricle. But for a full confutation of this fancy, I refer the reader to Dr. *Lower's* treatise *De Corde*, cap. 2. And *Des Cartes's* rules concerning the transferring of motion from one body in motion to another in motion, or in rest, are the most of them by experience found to be false; as they affirm who have made trial of them.

The pulse of the heart Dr. *Cudworth* would have to be no mechanical, but a vital motion, which to me seems probable, because it is not under the command of the will; nor are we conscious of any power to cause or to restrain it, but it is carried on and continued without our knowledge, or notice; neither can it be caused by the impulse of any external movent, unless it be heat. But how can the spirit, agitated by heat, unguided by a *vital principle*, produce such a regular reciprocal motion? If that site which the heart and its fibres have in the *diastole* be most natural to them, (as it seems to be) why doth it again contract itself, and not rest in that posture? If it be once contracted in a *systole* by the influx of the spirits, why, the spirits continually flowing in without let, doth it not always remain so? [for the *systole* seems to resemble the forcible bending of a spring, and the *diastole* its flying out again to its natural site.] What is the spring and principal efficient of this reciprocation? What directs and moderates the motions of the spirits? They being but stupid and senseless matter, cannot of themselves continue any regular and constant motion, without the guidance and regulation of some intelligent Being. You will say, What agent is it which you would



have to effect this? The sensitive soul it cannot be, because that is indivisible; but the heart when separated wholly from the body in some *animals*, continues still to pulse for a considerable time: Nay, when it hath quite ceas'd, it may be brought to beat a-new by the application of warm spitile, or by pricking it gently with a pin, or needle. I answer, it may be in these instances, the scattering spirits remaining in the heart, may for a time, being agitated by the heat, cause these faint pulsations; though I should rather attribute them to a *plastick nature*, or vital principle, as the vegetation of plants must also be.

But, to proceed, neither can I wholly acquiesce in the *Hypothesis* of that *honourable and deservedly famous author*, I formerly had occasion to mention, which I find in his *free Enquiry into the vulgar Notion of Nature*, p. 77, 78. deliver'd in these words. "I think it probable, that the great and  
 "wise author of things did, when he first form'd  
 "the universe and undistinguish'd matter into the  
 "world, put its parts into various motions, where-  
 "by they were necessarily divided into number-  
 "less portions of differing bulks, figures, and si-  
 "tuations, in respect of each other: And that by  
 "his infinite wisdom and power, he did so guide  
 "and over-rule the motions of these parts, at the  
 "beginning of things, as that (whether in a shor-  
 "ter or a longer time, reason cannot determine)  
 "they were finally dispos'd into that beautiful  
 "and orderly frame that we call the *world*; a-  
 "mong whose parts some were so curiously con-  
 "triv'd, as to be fit to become the seed, or semi-  
 "nal principles, of plants and animals. And, I  
 "further conceive, that he settled such laws, or  
 "rules, of local motion among the parts of the  
 "universal matter, that by his ordinary and pre-  
 "serving concurrence, the several parts of the uni-

"verse

"verse thus once compleated, should be able to maintain the great construction, or system, and oeconomy of the mundane bodies, and propagate the species of living creatures." The same *Hypothesis* he repeats again, pag. 124, 125. of the same treatise.

This *Hypothesis*, I say, I cannot fully acquiesce in, because an intelligent being seems to me requisite to execute the laws of motion: For first, Motion being a fluent thing, and one part of its duration being absolutely independent upon another, it doth not follow, that because any thing moves this moment, it must necessarily continue to do so the next, unless it were actually possess'd of its future motion, which is a contradiction; but it stands in as much need of an efficient to preserve and continue its motion, as it did at first to produce it. Secondly, Let matter be divided into the subtilest parts imaginable, and these be mov'd as swiftly as you will, it is but a senseless and stupid being still, and makes no nearer approach to sense, perception, or vital energy, than it had before; and do but only stop the internal motion of its parts, and reduce them to rest, the finest and most subtile body that is, may become as gross, and heavy, and stiff, as steel, or stone. And, as for any external laws, or establish'd rules of Motion, the stupid matter is not capable of observing, or taking any notice of them, but would be as sullen as the mountain was that *Mahomet* commanded to come down to him; neither can those laws execute themselves: Therefore there must, besides matter and law, be some efficient, and that either a quality, or power, inherent in the matter itself, which is hard to conceive, or some external intelligent agent, either God himself immediately, or some *plastick nature*.

Happening lately to read *The Christian Virtuoso*, written by the same author of the *Enquiry into the vulgar Notions of Nature*, (the illustrious Mr. Boyle) I find therein these words: "Nor will the  
 "force of all that has been said for God's special  
 "providence be eluded, by saying, with some  
 "Deists, That after the first formation of the  
 "universe, all things were brought to pass by  
 "the settled laws of nature. For though this be  
 "confidently, and not without colour, pretended,  
 "yet, I confess, it doth not satisfie me:—For I  
 "look upon a law as a moral, not physical cause,  
 "as being indeed but a notional thing, according  
 "to which an intelligent and free agent is bound  
 "to regulate its actions. But inanimate bodies  
 "are utterly incapable of understanding what it  
 "is, or what it enjoins, or when they act conformably, or unconformably to it: Therefore the  
 "actions of inanimate bodies, which cannot incite, or moderate their own actions, are produced by real power, not by laws."

All this being consonant to what I have here written, against what I took to be this honourable person's *Hypothesis*, I must needs, to do him right, acknowledge myself mistaken; perceiving now, that his opinion was, that God Almighty did not only establish laws and rules of local motion among the parts of the universal matter, but did, and does also himself, execute them, or move the parts of matter, according to them: So that we are in the main agreed, differing chiefly about the agent that executes those laws, which he holds to be God himself immediately, we a plastick nature; for the reasons alledg'd by Dr. Cudworth, in his system, p. 149. which are, First, Because the former, according to vulgar apprehension, would render the divine providence operose, solicitous, and distractions; and thereby make the belief of it



entertain'd with greater difficulty, and give advantage to atheists. Secondly, It is not so decorous in respect of God, that he should *αὐτοῦργεῖν πάντα*, set his own hand, as it were, to every work, and immediately do all the meanest and triflingest things himself drudgingly, without making use of any inferior or subordinate minister. These two reasons are plausible, but not cogent; the two following are of greater force. Thirdly, The slow and gradual process that is in the generation of things which would seem to be a vain and idle pomp, or trifling formality, if the agent were omnipotent. Fourthly, Those *ἀμαρτήματα*, as *Aristotle* calls them, those errors and bumbles which are committed when the matter is inept, or contumacious, as in monsters, &c. which argue the agent not to be irresistible; and that nature is such a thing as is not altogether incapable, as well as human art, of being sometimes frustrated and disappointed by the indisposition of the matter: whereas an omnipotent agent would always do its work infallibly and irresistibly, no ineptitude, or stubbornness of the matter being ever able to hinder such an one, or make him bungle, or fumble in any thing. So far the doctor. For my part, I should make no scruple to attribute the formation of *Plants*, their growth and nutrition, to the vegetable soul in them; and likewise the formation of *Animals*, to the vegetative power of their souls; but that the segments and cuttings of some plants, nay, the very chips and smallest fragments of their body, branches, or roots, will grow and become perfect plants themselves, and so the vegetable soul, if that were the architect, would be divisible, and consequently no spiritual, or intelligent being; which the *Plastick principle* must be, as we have shewn: For that must preside over the whole oeconomy of the plant, and be one single agent, which

takes care of the bulk and figure of the whole, and the situation, figure, texture of all the parts, root, stalk, branches, leaves, flowers, fruit, and all their vessels and juices. I therefore incline to Dr. Cudworth's opinion, that God uses for these effects the subordinate ministry of some inferior *plastick nature*; as, in his works of providence, he doth of angels. For the description whereof I refer the reader to his *system*.

Secondly, In particular I am difficult to believe, that the *bodies of animals* can be form'd by matter divided and mov'd by what laws you will, or can imagine, without the immediate presidency, direction, and regulation of some intelligent being. In the generation, or first formation of, suppose, the human body out of (tho' not an homogeneous liquor, yet) a fluid substance, the only material agent, or mover, is a moderate heat. Now how this, by producing an intestine motion in the particles of the matter, which can be conceiv'd to differ in nothing else but figure, magnitude, and gravity, should, by virtue thereof, not only separate the heterogeneous parts, but assemble the homogeneous into masses, or systems, and that not each kind into one mass, but into many and disjoin'd ones, as it were so many troops; and that in each troop the particular particles should take their places, and cast themselves into such a figure; as for example, the bones, being about 300, are form'd of various sizes and shapes, so situate and connected, as to be subservient to many hundred intentions and uses, and many of them conspire to one and the same action, and all this contrarily to the laws of specifick gravity, in whatever posture the body be form'd; for the bones, whose component parts are the heavier, will be above some parts of the flesh which are the lighter; how much more then, seeing it is  
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form'd with the head, (which for its bigness is the heaviest of all the parts) uppermost. This, I say, I cannot by any means conceive. I might instance in all the homogeneous parts of the body, either sizes and figures, and ask by what imaginable laws of motion their bulk, figure, situation, and connection can be made out? What account can be given of the valves, of the veins and arteries of the heart, and of the veins elsewhere, and of their situation; of the figure and consistency of all the humours and membranes of the eye, all conspiring and exactly fitted to the use of seeing? But I have touch'd upon that already, and shall discourse it largely afterward. You will ask me, Who, or what, is the operator in the formation of the bodies of man, and other animals? I answer, The sensitive soul itself, if it be a spiritual and immaterial substance, as I am inclinable to believe; but if it be material, and consequently the whole animal but a mere machine or *Automaton*, as I can hardly admit, then must we have recourse to a *plastick nature*.

That the soul of brutes is material, and the whole animal, soul and body, but a mere machine, is the opinion, publickly own'd and declar'd, of *Des Cartes*, *Gassendus*, *Dr. Willis*, and others. The same is also necessarily consequent upon the doctrine of the Peripateticks, *viz.* That the sensitive soul is educ'd out of the power of the matter; for nothing can be educ'd out of the matter but what was there before; which must be either matter, or some modification of it. And therefore they cannot grant it to be a spiritual substance, unless they will assert it to be educ'd out of nothing. This opinion, I say, I can hardly digest: I should rather think, animals to be endu'd with a lower degree of reason, than that they are mere machines. I could instance in many actions of  
brutes,



*brutes*, that are hardly to be accounted for without reason and argumentation; as that commonly noted of dogs, that running before their masters, they will stop at a divarication of the way, 'till they see which hand their masters will take; and that when they have gotten a prey, which they fear their masters will take from them, they will run away and hide it, and afterwards return to it. What account can be given why a dog, being to leap upon a table which he sees to be too high for him to reach at once, if a stool, or chair, happens to stand near it, doth first mount up that, and from thence the table? If he was a machine, or piece of clockwork, and this motion caus'd by the striking of a spring, there is no reason imaginable why the spring, being set on work, should not carry the machine in a right line toward the object that put it in motion, as well when the table is high as when it is low; whereas I have often observ'd the first leap the creature hath taken up the stool, not to be directed toward the table, but in a line oblique, and much declining from the object that mov'd it, or that part of the table on which it stood.

Many the like actions there are, which I shall not spend time to relate. Should this be true, that beasts were *Automata*, or machines, they could have no sense, or perception of pleasure, or pain, and consequently no cruelty could be exercis'd towards them; which is contrary to the doleful significations they make when beaten, or tormented, and contrary to the common sense of mankind, all men naturally pitying them, as apprehending them to have such a sense and feeling of pain and misery as themselves have; whereas no man is troubled to see a plant torn, or cut, or stamp't, or mangled how you please; and at last seemingly contrary to the scripture too; for it is said, *Pro.*

xii. 10. *A righteous man regardeth the life of his beast, but the tender mercies of the wicked are cruel.* The former clause is usually english'd, *A good man is merciful to his beast*; which is the true exposition of it; as appears by the opposite clause, that *the wicked are cruel*. What less then can be inferr'd from this place, than that cruelty may be exercis'd towards beasts, which, were they mere machines, it could not be? To which I do not see what can be answer'd, but that the Scripture accommodates itself to the common, tho' false, opinion of mankind, who take these animals to be endued with sense of pain, and think that cruelty may be exercis'd towards them; tho', in reality, there is no such thing: Besides, having the same members and organs of sense as we have, it is very probable they have the same sensations and perceptions with us. To this *Des Cartes* answers, or indeed saith, he hath nothing to answer; but that if they think as well as we, they have an immortal soul as well as we: Which is not at all likely, because there is no reason to believe it of some animals without believing it of all; whereas there are many too imperfect to believe it of them, such as are *Oysters*, and *Sponges*, and the like. To which I answer, That there is no necessity they should be immortal, because it is possible they may be destroy'd, or annihilated. But I shall not wade further into this controversy, because it is beside my scope, and there hath been as much written of it already, as I have to say, by *Dr. Moore*, *Dr. Sudworth*, *Des Cartes*, *Dr. Willis*, and others, *pro and con*.

*Of the visible Works of God, and their division.*

I come now to take a view of the works of the creation, and to observe something of the wisdom

of God discernable in the formation of them, in their order and harmony, and in their ends and uses: And first, I shall run them over slightly, remarking chiefly what is obvious and expos'd to the eyes and notice of the more careless and in-curious observer. Secondly, I shall select one or two particular pieces, and take a more exact survey of them; tho' even in these, more will escape our notice than can be discover'd by the most diligent scrutiny; for our eyes and senses, however arm'd or assisted, are too gross to discern the curiosity of the workmanship of nature, or those minute parts by which it acts, and of which bodies are compos'd; and our understanding too dark and infirm to discover and comprehend all the ends and uses to which the infinitely wise Creator did design them.

But before I proceed, being put in mind thereof by the mention of the assistance of our eyes, I cannot omit one general observation concerning the curiosity of the works of nature in comparison of the works of art, which I shall propose in the late bishop of *Chester's* words, (*Treatise of Natural Religion*, Lib. 1. c. 6.) "The observations which have been made in these latter times by the help of the *microscope*, since we had the use and improvement of it, discover a vast difference between natural and artificial things. Whatever is natural, beheld thro' that, appears exquisitely form'd, and adorn'd with all imaginable elegance and beauty. There are such inimitable gildings in the smallest seeds of plants, but especially in the parts of animals, in the head, or eye, of a small fly; such accuracy, order, and symmetry in the frame of the utmost minute creatures, a *Louse*, for example, or a *Mite*, as no man were able to conceive without seeing of them. Whereas the most cu-

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needle, doth appear as a blunt rough bar of  
iron, coming from the furnace, or the forge :  
The most accurate engravings, or embosments,  
seem such rude, bungling, and deform'd work,  
as if they had been done with a mattock, or  
trowel ; so vast a difference is there betwixt the  
skill of nature, and the rudeness and imperfec-  
tion of art. I might add, that the works of na-  
ture, the better lights and glasses you use, the  
more clear and exactly form'd they appear ;  
whereas the effects of human art, the more cu-  
riously they are view'd and examin'd, the more  
of deformity they discover."

This being premised, for our more clear and distinct proceeding in our cursory view of the creation, I shall rank the parts of this material and visible world under several heads. Bodies are either *inanimate* or *animate*. *Inanimate* bodies are either *cælestial* or *terrestrial*. *Cælestial*, as the *Sun*, *Moon*, and *Stars* ; *Terrestrial*, are either *simple*, as the four elements, *Fire*, *Water*, *Earth*, and *Air* ; or *mixt*, either *imperfectly*, as the *Meteors*, or more perfectly, as *Stones*, *Metals*, *Minerals*, and the like. *Animate* bodies are either such as are endued with a *vegetative* soul, as plants ; or a *sensitive* soul, as the bodies of *Animals*, *Birds*, *Beasts*, *Fishes*, and *Insects* ; or a *rational* soul, as the body of *Man*, and the vehicles of *Angels*, if any such there be.

I make use of this division to comply with the common and receiv'd opinion, and for easier comprehension and memory ; tho' I do not think it agreeable to philosophick verity and accuracy, but do rather incline to the *Atomick Hypothesis* : For these bodies, we call *Elements*, are only the ingredients of mix'd bodies ; neither are they absolutely simple themselves, as they do exist in the world,

world, the sea-water containing a copious salt manifest to sense; and both sea and fresh-water sufficing to nourish many species of fish, and consequently containing the various parts of which their bodies are compounded. And I believe there are many species of bodies which the *Peripateticks* call mix'd, which are as simple as the *elements* themselves, as *Metals*, *Salts*, and some sorts of *Stones*. I should therefore, with Dr. *Grew*, and others, rather attribute the various species of inanimate bodies to the diverse figures of the minute particles of which they are made up: And the reason why there is a set, and constant number, of them in the world, none destroy'd, nor any new ones produc'd, I take to be, because the sum of the figures of those minute bodies into which matter was at first divided, is determinate and fix'd. 2. Because those minute parts are indivisible, not absolutely, but by any natural force; so that there neither is, nor can be, more or fewer of them: For were they divisible into small and diversly figur'd parts by fire, or any other natural agent, the species of nature must be confounded; some might be lost and destroy'd, but new ones would certainly be produc'd, unless we could suppose these new diminutive particles should again assemble and marshal themselves into corpuscles of such figures as they compounded before; which I see no possibility for them to do, without some *Θεὸς ἀπὸ μυχῶν* to direct them: Not that I think these inanimate bodies to consist wholly of one sort of *Atoms*, but that their bulk consists mainly or chiefly of one sort. But whereas it may be objected that metals (which of all others seem to be most simple) may be transmuted one into another, and so the *species* doth not depend upon the being compounded of *Atoms* of one figure; I answer, I am not fully satisfied of the

the matter of fact: But if any such transmutation be, possibly all metals may be of one species, and the diversity may proceed from the admixture of different bodies with the principles of the metal. If it be ask'd, Why may not atoms of different species concur to the composition of bodies? And so, tho' there be but a few sorts of original principles, may there not be produced infinite species of compound bodies, as by the various dispositions and combinations of twenty-four letters innumerable words may be made up? I answer, because the heterogeneous atoms or principles are not naturally apt to cohere and stick together when they are mingled in the same liquor, as the homogeneous readily do.

I do not believe that the species of principles, or indivisible particles, are exceeding numerous; but possibly the immediate component particles of the bodies of plants and animals may be themselves compounded.

*Of the Heavenly Bodies.*

Before I come to treat of the heavenly bodies in particular, I shall premise in general, that the whole universe is divided into two sorts of bodies, the one very thin and fluid, the other more dense, solid and consistent. The thin and fluid is the *Ether*, comprehending the air or Atmosphere encompassing the particular stars and planets. Now, for the stability and perpetuity of the whole universe, the divine wisdom and providence hath given to the solid and stable parts a two-fold power, one of gravity, and the other of circular motion. By the first they are preserv'd from dissolution and dissipation, which the second would otherwise infer: For it being by the consent of philosophers, an innate property of every body mov'd circularly

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about any centre, to recede, or endeavour to recede, from that centre of its motion, and the more strongly the swifter it is mov'd, the stars and planets being whirl'd about with great velocity, would suddenly, did nothing inhibit it, at least in a short time, be shatter'd in pieces, and scatter'd every way thro' the *Ether*. But now their gravity unites and binds them up fast, hindering the dispersion of their parts. I will not dispute what gravity is; only I will add, that, for ought I have heard, or read, the Mechanical philosophers have not as yet given a clear and satisfactory account of it.

The second thing is a circular motion upon their own *Axes*, and in some of them also, 'tis probable, about other points, if we admit the *Hypothesis* of every fix'd star's being a sun or sun-like body, and having a choir of planets in like manner moving about him. These revolutions, we have reason to believe, are as exactly equal and uniform as the earth's are; which could not be, were there any place for chance, and did not a providence continually over-see and secure them from all alteration or imminution, which either internal changes in their own part, or external accidents and occurrences, would at one time or other necessarily induce. Without this circular motion of the earth, here could be no living: One Hemisphere would be condemn'd to perpetual cold and darkness, the other continually roasted and parch'd by the sun-beams. And it is reasonable to think, that this circular motion is as necessary to most other planetary bodies, as it is to the earth. As for the fix'd stars, if they be sun-like bodies, it is probable also each of them moves circularly upon its own *Axis*, as the sun doth: But what necessity there is of such a motion, for want of understanding the nature of those bodies, I must confess myself not yet to comprehend; tho' that it

is very great, I doubt not, both for themselves, and for the bodies about them.

First, For the celestial, or heavenly bodies, the equability and constancy of their motions, the certainty of their periods and revolutions, the conveniency of their order and situations, argue them to be ordain'd and govern'd by wisdom and understanding; yea, so much wisdom as man cannot easily fathom or comprehend: For we see, by how much the *Hypotheses* of Astronomers are more simple and conformable to reason, by so much do they give a better account of the heavenly motions. It is reported of *Alphonfus* king of *Arragon*, (I know not whether truly) that when he saw and consider'd the many *Eccentricks*, *Epicycles*, *Epicycles upon Epicycles*, *Librations*, and contrariety of motions, which were requisite in the old *Hypothesis* to give an account of the *Celestial Phænomena*, he should presume blasphemously to say, that the universe was a bungling piece; and that if he had been of God's counsel, he could have directed him to have made it better. A speech as rash and ignorant, as daring and prophane.

For it was nothing but ignorance of the true process of nature, that induced the contrivers of that *Hypothesis* to invent such absurd suppositions, and him to accept them for true, and attribute them to the great author of the heavenly motions: For in the new *Hypothesis* of the modern Astronomers, we see most of those absurdities and irregularities rectify'd and remov'd; and I doubt not but they would all vanish, could we certainly discover the true method and process of nature in those revolutions: For seeing in those works of nature which we converse with, we constantly find those axioms true, *Natura non facit circuitus*, nature doth not fetch a compass when it may proceed in a straight line; and *Natura nec abundat in superfluis*,

*nec deficit in necessariis*, Nature abounds not in what is superfluous, neither is deficient in what is necessary: we may also rationally conclude concerning the heavenly bodies, seeing there is so much exactness observ'd in the time of their motions, that they punctually come about in the same periods to the hundredth part of a minute, as may, beyond exception, be demonstrated by comparing their revolutions; surely there is also us'd the most simple, facile, and convenient way for the performance of them. Among these heavenly bodies,

First, The *Sun*, a vast globe of fire esteem'd by the ancients and most modest computation above 160 times bigger than the earth; the very life of this inferior world, without whose salutary and vivifick beams, all motion, both animal, vital and natural, would speedily cease, and nothing be left here below but darkness and death. All plants and animals must needs in a very short time be not only mortified, but, together with the surface of land and water, frozen as hard as a flint or adamant: So that of all the creatures of the world, the ancient heathens had most reason to worship him as God, tho' no true reason; because he was but a creature, and not God: And we Christians do think, that the service of the animals that live upon the earth, and principally man, was one end of his creation; seeing without him there could no such things have been. This *Sun*, I say, according to the old *Hypothesis*, whirl'd round about the earth daily with incredible celerity, making night and day by his rising and setting; winter and summer, by his access to the several tropicks, creating such a grateful variety of seasons, enlightening all parts of the earth by his beams, and cherishing them by his heat, situate and mov'd so in respect of this sublunary world, (and 'tis likely also in respect of all the planets about him)



him) that art and counsel could not have design'd either to have placed him better, or mov'd him more conveniently for the service thereof, as I could easily make appear by the inconveniences that would follow upon the supposition of any other situation and motion, shew forth the great wisdom of him who so dispos'd and mov'd him.

Secondly, The *Moon*, a body in all probability somewhat like the earth we live upon, by its constant and irregular motion, helps us to divide our time, reflects the sun-beams to us, and so by illuminating the air, takes away in some measure the disconsolate darkness of our winter-nights; procures, or at least regulates, the fluxes and refluxes of the sea, whereby the water is kept in constant motion, and preserv'd from putrefaction, and so render'd more salutary for the maintenance of its breed, and useful and serviceable for man's convenience of fishing and navigation; not to mention the great influence it is suppos'd to have upon all moist bodies, and the growth and increase of vegetables and animals: Men generally observing the age of the *Moon* in the planting of all kinds of trees, sowing of grain, grafting and inoculating, and pruning of fruit-trees, gathering of fruit, cutting of corn or grass; and thence also making prognosticks of weather, because such observations seem to me uncertain. Did this *Luminary* serve to no other ends and uses, as I am perswaded it doth many, especially to maintain the creatures which in all likelihood breed and inhabit there, for which I refer you to the ingenious treatises written by Bishop *Wilkins*, and monsieur *Fontenelle*, on that subject; yet these were enough to evince it to be the effect and product of divine wisdom and power.

Thirdly, As for the rest of the *Planets*, besides their particular uses, which are to us unknown,

or merely conjectural, their courses and revolutions, their stations and retrogradations, observ'd constantly so many ages together in most certain and determinate periods of time, do sufficiently demonstrate, that their motions are instituted and govern'd by counsel, wisdom and understanding.

Fourthly, The like may be said of the *fix'd stars*, whose motions are regular, equal and constant: So that we see nothing in the heavens which argues chance, vanity, or error; but on the contrary, rule, order, and constancy; the effects and arguments of wisdom: Wherefore, as *Cicero* excellently concludes, *Cœlestem ergo admirabilem ordinem, incredibilemque constantiam, ex qua conversatio & scelus omnium omnis oritur, qui vacare mente putat, nœ ipse mentis expers habendus est*: "Wherefore whosoever thinketh that the admirable  
" order, and incredible constancy, of the heavenly  
" bodies, and their motions, whereupon the preservation, and welfare of all things doth depend  
" is not govern'd by mind and understanding, he  
" himself is to be accounted void thereof." And again, " Shall we (saith he) when we see an artificial engine, as a sphere or dial, or the like,  
" at first sight acknowledge, that it is a work of  
" reason and art? *Cum autem impetum cœli, admirabili cum celeritate moveri vertique videamus, constantissime conficientem vicissitudines anniversarias, cum summa salute & conservatione rerum omnium, dubitare quin ea non solum ratione fiant, sed excellenti quadam divinaque ratione*: " And  
" can we, when we see the force of the heavens  
" mov'd and whirl'd about with admirable celerity, most constantly finishing its anniversary vicissitudes, to the eminent welfare and preservation of all things, doubt at all that these things  
" are performed not only by reason, but by a certain excellent and divine reason? "

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To these things I shall add an observation, which I must confess to myself to have borrowed of the honourable person more than once mentioned already, that even the *Eclipses* of the *Sun* and *Moon*, tho' they be frightful things to the superstitious vulgar, and of ill influence on mankind, if we may believe the no less superstitious Astrologers, yet to knowing men, that can skilfully apply them, are of great use, and such as common heads could never have imagined: Since not only they may on divers occasions, help to settle *Chronology*, and rectify the mistakes of *Historians* that writ many ages ago; but which is, tho' a less wonder, yet of greater utility, they are (as things yet stand) necessary to define with competent certainty, the longitude of places or points on the Terraqueous globe, which is a thing of very great moment not only to *Geography*, but to the most useful and important art of *Navigation*. To which may be added, which I shall hereafter mention, that they serve to demonstrate the spherical roundness of the earth: So that I may well conclude with the Psalmist, Psal. xix. 1. *The heavens declare the glory of God, and the firmament sheweth his handy-work.*

*Of Terrestrial and Inanimate Simple Bodies.*

I come now to consider the terrestrial bodies. I shall say nothing of the whole body of the Earth in general, because I reserve that as one of the particulars I shall more carefully and curiously examine.

Terrestrial bodies, according to our method before propounded, are either *inanimate*, or *animate*; and the *inanimate* either *simple*, or *mixt*; *simple*, as the four elements, *Fire*, *Water*, *Earth*, and *Air*: I call these *Elements* in compliance (as I said before) with the vulgarly-received opinion; not that I think them to be the principles or com-



ponent ingredients of all other sublunary bodies: I might call them the four great aggregates of bodies of the same species, or four sorts of bodies, of which there are aggregates. These, notwithstanding they are endued with contrary qualities, and are continually encroaching one upon another, yet they are so balanced, and kept in such an *Equilibrium*, that neither prevaleth over other, but what one gets in one place it loseth in another.

First, *Fire* cherisheth and reviveth by its heat, without which all things would be torpid, and without motion, nay, without fire, no life, it being the vital flame residing in the blood that keeps the bodily machine in motion, and renders it a fit organ for the soul to work by. The uses of fire (I do not here speak of the Peripateticks elementary fire in the concave of the Moon, which is but a mere figment, but our ordinary culinary) are in a manner infinite for dressing and preparing of victuals, baked, boiled and roast; for melting and refining of metals and minerals; for the fusion of glass, [a material whose uses are so many, that it is not easy to enumerate them, it serving us to make windows for our houses, drinking vessels to distill and preserve all sorts of fermented liquors, and distilled water, spirits, oils, extracts, and other chymical preparations, as also vessels to distil and prepare them in; for looking-glasses, spectacles, microscopes and telescopes, whereby our sight is not only relieved, but wonderfully assisted to make rare discoveries] for making all sorts of instruments for husbandry, mechanical arts and trades, all sorts of arms or weapons of war defensive and offensive; for fulminating engines; for burning of lime, baking of bricks, tiles, and all sorts of potters vessels, or earthen ware; for casting and forming metaline vessels and utensils; for distillations, and all chymical opera-

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operations hinted before in the use of glass; for affording us lights for any work or exercise in Winter-nights; for digging in mines and dark caverns; and finally, by its comfortable warmth securing us from the injuries of cold, or relieving us when we have been bitten and benumb'd with it. A subject or utensil of so various and inexplicable use, who could have invented and form'd, but an infinitely wise and powerful efficient?

Secondly, The *Air* serves us, and all animals, to breathe in, containing the fewel of that vital flame we speak of, without which it would speedily languish and go out; so necessary it is for us, and other land animals, that without the use of it we could live but very few minutes: Nay, fishes and other water-animals cannot abide without the use of it; for if you put fishes into a vessel of a narrow mouth full of water, they will live and swim there, not only days and months, but even years; but if with your hand, or any other cover, you stop the vessel so as wholly to exclude the air, or interrupt its communication with the water, they will suddenly be suffocated; as *Rondeletius* affirms he often experimented. If you fill not the vessel up to the top, but leave some space empty for the air to take up, and then clap your hand upon the mouth of the vessel, the fishes will presently contend which shall get uppermost in the water, that so they may enjoy the open air; which I have also observ'd them to do in a pool of water that hath been almost dry in the Summer-time, because the air that insinuated itself into the water did not suffice them for respiration. Neither is it less necessary for insects than it is for other animals, but rather more, these having more air-vessels for their bulk by far than they, there being many orifices on each side their bodies for the admission of air, which if you stop with oil or honey, the insect pre-

presently dies, and revives no more. This was an observation of the ancients, tho' the reason of it they did not understand; (*Oleo illito insecta omnia exanimantur*. Plin.) which was nothing but the intercluding of the air; for tho' you put oil upon them, if you put it not upon, or obstruct those orifices therewith, whereby they draw the air, they suffer nothing: If you obstruct only some, and not others, the parts which are near and supplied with air, from thence are by and by convulsed, and shortly relaxed and deprived of motion, the rest that were untouched still retaining it. Nay, more than all this, plants themselves have a kind of respiration, being furnished with plenty of vessels for the derivation of air to all their parts; as hath been observed, nay, first discovered, by that great and curious naturalist *Malpighius*. Another use of the air is to sustain the flight of birds and insects. Moreover, by its gravity it raises the water in pumps, siphons, and other engines, and performs all those feats which former philosophers thro' ignorance of the efficient cause, attributed to a final, namely nature's abhorrence of a vacuity or empty space. The elastick or expansive faculty of the air, whereby it dilates itself, when compressed, (indeed this lower region of it, by reason of the weight of the superincumbent, is always in a compressed state) hath been made use of in the common weather-glasses, in wind-guns, and in several ingenious water-works, and doubtless hath a great interest in many natural effects and operations.

Against what we have said of the necessity of the air for the maintenance of the vital flame it may be objected, That the *Fætus* in the womb lives, its heart pulses, and its blood circulates; and yet it draws in no air, neither hath the air any access to it. To which I answer, That it

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Part I. doth receive air, so much as is sufficient for it in its present state, from the maternal blood by the *Placenta Uterina*, or the *Cotyledons*. This opinion generally propounded, viz. That the respiration of the dam did serve the *Fætus* also, or supply sufficient air to it, I have met with in books; but the explicit notion of it I owe to my learned and worthy friend Dr. *Edward Hulse*, which, comparing with mine own anatomical observations, I found so consonant to reason, and highly probable, that I could not but yield a firm assent to it. I say then, That the chief use of the circulation of the blood thro' the *Cotyledons* of a calf in the womb, (which I have often dissected) and by analogy thro' the *Placenta Uterina* in an human *Fætus*, seems to be the impregnation of the blood with air, for the feeding of the *vital flame*: For if it were only for nutrition, what need of two such great arteries to convey the blood thither? it would (one might rationally think) be more likely, that as in the *Abdomen* of every animal, so here, there should have been some lacteal veins formed, beginning from the *Placenta*, or *Cotyledons*, which concurring in one common *Ductus*, should at last empty themselves into the *Vena Cava*. Secondly, I have observed in a calf, the umbilical vessels to terminate in certain bodies divided into a multitude of carneous *Papillæ*, (as I may so call them) which are received into so many sockets of the *Cotyledons* growing in the womb; which carneous *Papillæ* may without force, or laceration, be drawn out of those sockets. Now these *Papillæ* do well resemble the *Aristæ*, or *Radii*, of a fish's gills, and very probably have the same use to take in the air; so that the maternal blood which flows to the *Cotyledons*, and encircles these *Papillæ*, communicates by them to the blood of the *Fætus*, the air wherewith itself is impregnate; as the water flowing about

about the carneous *Radii* of the fish's gills doth the air that is lodged therein to them. Thirdly, That the maternal blood flows most copiously to the *Placenta Uterina* in women, is manifest from the great hemorrhagy that succeeds the separation thereof at the birth. Fourthly, After the stomach and intestines are formed, the *Fœtus* seems to take in its whole nourishment by the mouth, there being always found in the stomach of a calf, plenty of the liquor contained in the *Amnios* wherein he swims, and *Fæces* in his intestines, and abundance of urine in the *Allantoides*; so that the *Fœtus* in the womb doth live, as it were, the life of a fish. Lastly, Why else should there be such an instant necessity of respiration so soon as ever the *Fœtus* is fallen off from the womb?

I know that if the *Fœtus* be taken out of the womb inclosed in the secundines, it will continue to live, and the blood to circulate for a considerable time, as Dr. *Harvey* observes. The reason whereof I conceive to be, because the blood still circulates thro' the *Cotyledons*, or *Placenta*, which are now exposed to the open air, and so from thence receives sufficient supplies thereof, to continue its gentle motion, and feed the vital flame. But when, upon the exclusion of the young, the umbilical vessels are broken, and no more air is received that way, the plastick nature, to preserve the life of the animal, speedily raises the lungs, and draws into them air in great abundance, which causes a sudden and mighty ascension in the blood; to the maintainance whereof a far greater quantity of air is requisite, than would serve to feed the mild and languid flame before.

This way we may give a facile and very probable account of it, to wit, because receiving no more communications of air from its dam, or mother, it must needs have a speedy supply from without,

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Upon this occasion, give me leave to discourse a little concerning the air's insinuating itself into the water. I say therefore, That the air, at least that part of it which is the aliment of fire, and fewel of the vital flame in animals, easily penetrates the body of water exposed to it, and diffuseth itself thro' every part of it. Hence it is that we find fish in subterraneous rivers, and fossil fish in the earth itself; which can no more live without air there than in the open waters: Hence the miners, when they come once at water, are out of all danger of damps. You'll say, How gets the air into the water in subterraneous rivers, and into the earth to the fossil fishes? I answer, The same way that the water doth: Which I suppose to be by its upper superficies: the water descending by pores and passages that there it finds into chinks and veins, and by confluence of many of them by degrees swelling into a stream, the air accompanies and follows it by a constant succession. As for fossil fishes, some make their way into the earth up the veins of water, opening into the banks of rivers, where they ly till they grow so great that they cannot return: In which veins they find air enough to serve their turn, needing not much by reason that they lie still and move but little. Others in times of floods are left in the meadows, and with the water sink into the earth at some holes and pores that the water finds, or makes, by which also they are supplied with air. The reason why the miners are out of danger of damps when they come to water, I conceive is, because then presently the air that stagnated in the shafts sinks into the water, and fresh air descends and succeeds, and so there is a



circulation; in the same manner as by the sinking of an air-shaft the air hath liberty to circulate, and carry out the steams both of the miners breath and the damp, which would otherwise stagnate there. Indeed, though there were no damp, yet the nitrous part of the air being spent and consumed by the breathing of the miners, the remaining part should be rendered altogether unfit for respiration, unless new and fresh air could succeed.

And here, methinks, appears a necessity of bringing in the agency of some superintendent intelligent Being, be it a *Plastick Nature*, or what you will: For what else should put the Diaphragm, and all the muscles serving to respiration, in motion all of a sudden so soon as ever the *Fœtus* is brought forth? Why could they not have rested as well as they did in the womb? What aileth them that they must needs bestir themselves to get in air to maintain the creatures life? Why could they not patiently suffer it to die? That the air of itself could not rush in, is clear; for that, on the contrary, there is required some force to remove the incumbent air, and make room for the external to enter. You will say, the spirits do at this time flow to the organs of respiration, the Diaphragm and other muscles which concur to that action and move them. But what rouses the spirits which were quiescent during the continuance of the *Fœtus* in the womb? Here is no appearing impellent but the external air, the body suffering no change but of place, out of its close and warm prison into the open and cold air: But how, or why, that should have such an influence upon the spirits, as to drive them into those muscles electively, I am not subtil enough to discern. As for the respiration of the chick in the egg, I suppose the air not only to be included in the white, but also to be supply'd thro' the shell and membranes.

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Thirdly, *Water* is one part, and that not the least of our sustenance, and that affords the greatest share of matter in all productions; being not (as it exists in the world) a simple and unmixed body, but containing in it the principles, or minute component particles of all bodies: To speak nothing of those inferiour uses of washing and bathing, dressing and preparing victuals. But if we shall consider the great *Concepticula* and congregations of water, and the distribution of it all over the dry land in the springs and rivers, there will occur abundant arguments of wisdom and understanding. The sea, what infinite variety of fishes doth it nourish! *Psal. civ. 25.* In the verse next to my text, *The earth is full of thy riches: So is this great and wide sea, wherein are things creeping innumerable, both small and great beasts, &c.* How doth it exactly compose itself to a level, or equal superficies, and in the earth make up one spherical roundness? How doth it constantly observe its ebbs and flows, its spring and nepe-tides, and still retains its saltness, so convenient for the maintenance of its inhabitants, serving also the uses of man for Navigation, and the convenience of carriage? That it should be confined by shores, and strands, and limits, I mean at first, when it was natural to it to overflow and stand above the earth. All these particulars declare abundance of wisdom in their primitive constitution. This last the Psalmist takes notice of in the 6th, 7th, 8th, and 9th, verses of this *Psalms*: Speaking of the earth at the first creation, he saith, *Thou coveredst it with the deep as with a garment, the waters stood above the mountains: At thy rebuke they fled, at the voice of thy thunder they hasted away (the mountains ascend, the valleys descend) unto the place thou hast prepared for them. Thou hast set a bound that they may not pass over: That they*

*turn not again to cover the earth.* But what need was there (may some say) that the sea should be made so large, that its *Superficies* should equal, if not exceed, that of the dry land? Where is the wisdom of the Creator in making so much useless sea, and so little dry land, which would have been far more beneficial and serviceable to mankind? Might not at least half the sea have been spared, and added to the land, for the entertainment and maintenance of men, who by the continual striving and fighting to enlarge their bounds, and encroaching upon one another, seem to be straitned for want of room?

To this objection against the wisdom of God in thus dividing *Sea and Land*, Mr. Keill, in his *examination of Dr. Burnet's Theory of the earth*, p. 92, 93. thus answers: *This, as most other of the Atheists arguments, proceeds from a deep ignorance of natural philosophy; for if there were but half the sea that now is, there would be also but half the quantity of vapours, and consequently we could have but half so many rivers as now there are to supply all the dry land we have at present, and half as much more; for the quantity of vapours which are raised, bears a proportion to the surface whence they are raised, as well as to the heat which raised them. The wise Creator therefore did so prudently order it, that the sea should be large enough to supply vapours sufficiently for all the land, which it would not do if it were less than now it is.*

But against this it may be objected, why should not all the vapours which are raised out of the sea fall down again into it by rain? Is there not as much reason that the vapours which are exhaled out of the earth should be carried down to the sea, as that those raised out of the sea be brought up upon the dry land? If some by winds be driven from the sea up land, others by the same cause will



will be blown down from land to sea, and so balancing one another, they will in sum fall equally upon sea and land; and consequently the sea contribute nothing to the watering of the earth, or the maintainance of rivers.

To which I answer, That as to the watering of the earth there needs no supply from the sea, there being sufficient water exhaled out of itself to do that; there is no more returned upon it by rain, so as to rest upon it, than an equivalent quantity to what was raised out of it.

But the rivers must be supply'd other ways. Our opinion is, that they have their supply from rain and vapours. The question is, Whence these vapours are brought? We answer, From the sea. But what brings them up from the sea? I answer, The winds: And so I am arrived at the main difficulty, Why should not the winds carry them that are exhaled out of the *earth* down to the *Sea*, as well as bring them up upon the earth, which are raised from the sea? Or, which is all one, why should not the wind blow indifferently from sea and land? To which I answer, That I must needs acknowledge myself not to comprehend the reason hereof. God is truly said, *Psal. cxxxv. 7. To bring the wind out of his treasures.* But the matter of fact is most certain, *viz.* That the winds do bring abundantly more vapours up from the sea than they carry down thither.

First, Because otherwise there can no account be given of *floods*. It is clear, That floods with us proceed from rain; and it is often a vast quantity of water they carry down to the sea. Whence come those vapours which supply all this water? I hope those who bring up springs and rivers from the great *abyss*, will not bring those vapours, which unite into drops, and descend in rain from thence too. Should they rise from the dry land only,

they would soon render it dry indeed ; more parched than the desarts of *Libya*. We should quickly come to an 'end of floods, and of rain too; if nothing were returned from the sea again ; not to mention, that the sea must needs in such a case overflow its shores, and enlarge its bounds.

But this way there is an easy account to be given. It is clear, that the sun doth exhale vapours both from sea and land ; and that the superficies of sea and land is sufficient to yield vapours for rain, rivers and floods, when heated to such a degree as the sun heats it : So that there wants only wind to bring up so great a proportion of vapours from the sea as may afford water for the floods ; that is, so much as is returned back again to the sea.

Some may perchance demand, To what purpose serve the floods ? What use is there of them ? I answer, To return back to the sea the surplusage of water after the earth is sated with rain. It may be further asked, What need more rain be poured upon the earth than is sufficient to water it ? I reply, That the rain brings down from the mountains and higher grounds a great quantity of earth, and in times of floods spreads it upon the meadows and levels, rendering them thereby so fruitful as to stand in need of no culture, or manuring. So we see the land of *Egypt* owes its great fertility to the annual overflowing of the river *Nilus* : And 'tis likely the countries bordering upon the river of *Ganges* may receive the like benefit by the overflowing thereof. Moreover all rain-water contains in it a copious sediment of terrestrial matter, which by standing it precipitates ; and is not a simple elementary water. This terrestrial matter serves for the nourishment of plants, and not the water itself, which is but a vehicle to derive this nutriment to all the parts of

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of the Plants: And therefore the more rain, the more of this nutritious matter may be precipitated upon the earth, and so the earth rendered more fruitful. Besides all this, 'tis not unlikely, that the rain-water may be endued with some vegetating or prolifick virtue, derived from some saline or oleose particles it contains: For we see, that aquatick plants, which grow in the very water, do not thrive and flourish in dry Summers, when they are not also watered with the dew of heaven.

Secondly, Another argument to prove, That the winds bring up more vapours from the sea than they carry down thither, is, Because the winds do more frequently blow from the sea than to the sea. This appears from the trees which grow on and near the sea-shores all along the Western coast of *England*, whose heads and boughs I have observed to run out far to landward; but toward the sea to be so snubed by the winds, as if their boughs and leaves had been pared or shaven off on that side.

It is also observed, that the western wind, which is the most violent and boisterous of all with us in *England*, which comes from off the great *Atlantick* ocean, is of longest continuance. *Julius Cæsar*, in his 5th book of *Commentaries de Bello Gallico*, saith of it, *Magnam partem omnis temporis in his locis fluere consuevit*; 'it is wont to blow in these quarters a great part of the whole year.' Which observation holds true at this day, the wind lying in that corner at least three quarters of the year.

Since this motion of the winds is constant, there is doubtless a constant and settled cause of it, which deserves to be enquired into, and searched out, by the study and endeavours of the most sagacious naturalist. But however the wind be raised, it may more easily blow from sea to land, than from land to sea, because the superficies of the sea be-  
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ing even, or level, there is nothing to stop its course; but on the land there are not only woods, but mountains to hinder and divert it.

Having myself seen so much of the bottom of the sea round about the coasts of *England*, and a great part of the *Low Countries*, of *Italy* and *Sicily*, I must needs adhere to what I delivered, That where the bottom of the sea is not rocky, but earth, owze, or sand, and that is incomparably the greatest part of it, it is by the motion of the waters, so far as the reciprocation of the sea extends to the bottom, brought to a level; and if it should be now unequal, would in time be level'd again. By level I do not mean so as to have no declivity (for the reciprocation preserves that, the flood hindering the constant carrying down of the bottom) but only to have an equal and uniform descent from the shores to the deeps. Now all those relations of urinators belong only to those places where they have dived, which are always rocky; for there is no reason why they should dive where the bottom is level and sandy. That the motion of the water descends to a good depth, I prove from those plants that grow deepest in the sea, because they generally grow flat, in manner of a fan, and not with branches on all sides like trees, which is so contrived by the providence of nature; for that the edges of them do in that posture with most ease cut the water flowing to and fro; and should the flat side be objected to the stream, it would soon be turned edge-wise by the force of it, because in that site it doth least resist the motion of the water: Whereas, did the branches of these plants grow round, they would be thrown backward and forward every tide.

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as I have observed in various kinds of *Corals* and *Pori*. Hence I suspect all those relations concerning trees growing at the bottom of the sea, and bringing forth fruit there: And as for the *Maldiva Nut*, till better information, I adhere to *Garcias's* opinion, which may be seen in *Clusius*. Farther, I do believe, that in the great depths of the sea, there grow no plants at all, the bottom being too remote from the external air, which though it may pierce the water so low, yet I doubt whether in quantity sufficient for the vegetation of plants: Nay, we are told, That in those deep and bottomless seas there are no fish at all; yet, not because there are no plants, or insects to feed them, for that they can live upon water alone, *Rondeletius's* experiment about keeping them in a glass doth undeniably prove, but because their spawn would be lost in those seas, the bottom being too cold for it to quicken there, or rather because being lighter than the water there, it would not sink to the bottom, but be buoyed up by it, and carried away to the shallows.

Again, The great use and convenience, the beauty and variety of so many springs and fountains, so many brooks and rivers, so many lakes and standing-pools of water, and these so scattered and dispersed all the earth over, that no great part of it is destitute of them; without which it must, without a supply otherways, be desolate and void of inhabitants, afford abundant arguments of wisdom and counsel: That springs should break forth on the sides of mountains most remote from the sea: That there should way be made for rivers thro' straits and rocks, and subterraneous vaults, so that one would think that nature had cut a way on purpose to derive the water, which else would overflow and drown whole countries: That the water passing thro' the veins of the earth, should

should be rendered fresh and potable, which it cannot be by any percolations we can make, but the saline particles will pass through a tenfold filter. That in some places there should spring forth metallick and mineral waters, and hot baths, and these so constant and permanent for many ages; so convenient for divers medicinal intentions and uses, the causes of which things, or the means and methods by which they are performed, have not been as yet certainly discovered; only in general *Pliny's* remark may be true, *Tales sunt aquae qualis terra per quam fluunt*. Hence they are cold, hot, sweet, stinking, purgative, diuretick or ferrugineous, saline, petrefying, bituminose, venenose, and of other qualities.

Lastly, The *Earth*, which is the basis and support of all animals and plants, and affords them the hard and solid part of their bodies, yielding us food and sustenance, and partly also cloathing; for I do not think that water supplies man, and other animals, or even plants themselves, with their nourishment, but serves chiefly for a vehicle to the alimentary particles, to convey and distribute them to the several parts of the body. Water, as it exists in the world, is not a simple unmixed body, but contains the terrestrial component parts of the bodies of animals and plants. Simple elementary water nourishes not at all. How variously is the surface of this earth distinguished into hills, and valleys, and plains, and high mountains, affording pleasant prospects. How curiously cloath'd and adorn'd, with the grateful verdure of herbs and stately trees, either dispersed and scattered singly, or as it were assembled in woods and groves, and all these beautified and illustrated with elegant flowers and fruits, *quorum omnium incredibilis multitudo, insatiabili varietate distinguitur*, as *Tully* saith. This also sheweth

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forth to them that consider it, both the power and wisdom of God: So that we may conclude with Solomon, Prov. viii. 19. *The Lord by wisdom hath founded the earth, by understanding hath he established the heavens.*

But now, if we pass from simple to mixed bodies, we shall still find more matter of admiration, and argument of wisdom. Of these we shall first consider those they call imperfectly mixed, or *Meteors*.

### Of METEORS.

As first of all, *Rain*, which is nothing else but water, by the heat of the sun divided into very small invisible parts, ascending into the air, till encountering the cold, it be by degrees condensed into clouds, and descends in drops; this though it be exhaled from the salt sea, yet by this natural distillation is rendered fresh and potable, which our artificial distillations have hitherto been hardly able to effect, notwithstanding the eminent use it would be of to Navigators, and the rewards promised to those that should resolve that problem of distilling fresh water out of salt. That the clouds should be so carried about by the winds, as to be almost equally dispersed and distributed, no part of the earth wanting convenient showers, unless when it pleaseth God, for the punishment of a nation, to withhold rain by a special interposition of his providence; or, if any land wants rain, they have a supply some other way; as the land of *Egypt*, tho' there seldom falls any rain there, yet hath abundant recompence made it by the annual overflowing of the river. This distribution of the clouds and rain is to me (I say) a great argument of providence and divine disposition; for else I do not see but why there might be in some lands continual successive droughts for many years,

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till they were quite depopulated; in others as lasting rains, till they were overflown and drowned and these, if the clouds moved casually, often happening; whereas, since the ancientest records of history, we do not read or hear of any such droughts or inundations, unless perhaps that of *Cyprus*, wherein there fell no rain there for thirty six years, till the island was almost quite deserted, in the reign of *Constantine*; which doubtless fell not out without the wise disposition of providence, for great and weighty reasons.

Again, If we consider the manner of the rain's descent, distilling down gradually, and by drops, which is most convenient for the watering of the earth; whereas if it should fall down in a continual stream like a river, it would gall the ground, wash away plants by the roots, overthrow houses, and greatly incommode, if not suffocate animals: If, I say, we consider these things, and many more that might be added, we might in this respect also cry out with the apostle, *O the depth of the riches both of the wisdom and knowledge of God!*

Secondly, Another meteor is the *Wind*; which how many uses it doth serve to, is not easy to enumerate, but many it doth, *viz.* to ventilate and break the air, and dissipate noisome and contagious vapours, which otherwise stagnating, might occasion many diseases, in animals; and therefore it is an observation concerning our native country, *Anglia ventosa, si non ventosa, venenosa*: To transfer the clouds from place to place, for the more commodious watering of the earth: To temper the excesses of the heat, as they find who in *Brasil*, *New Spain*, the neighbouring islands, and other the like countries near the equator, reap the benefit of the breezes: To fill the sails of ships, and carry them on their voyages to remote countries; which, of what eminent advantage it is

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to mankind, for the procuring and continuing of trade and mutual commerce between the most distant nations, the illustrating every corner of the earth, and the perfecting Geography and natural history, is apparent to every man. That the Monsoons and Trade-winds should be so constant and periodical, even to the 30th degree of latitude all round the globe, and that they should so seldom transgress or fall short of those bounds, is a subject worthy of the thoughts of the greatest philosophers. To this may be added the driving about of windmills for grinding of corn, making of oil, draining of pools, raising of water, sawing of wood, fulling of cloath, &c. That it should seldom or never be so violent and boisterous as to overturn houses, yea, whole cities; to tear up trees by the roots, and prostrate woods; to drive the sea over the lower countries; as, were it the effect of chance, or mere natural causes, not moderated by a superior power, it would in all likelihood often do. Hurricanes, spouts, and inundations, would be more frequent than they are. All these things declare the wisdom and goodness of him who bringeth the wind out of his treasures.

### *Of inanimate mixed Bodies.*

I proceed now to such inanimate bodies as are called *perfecte mixta*, perfectly mixed, improperly enough, they being many of them (for ought I know) as simple as those they call elements. These are *Stones, Metals, Minerals, and Salts*.

In *Stones*, which one would think were a neglected *Genus*, what variety? what beauty and elegance? what constancy in their temper, and consistency in their figures and colours? I shall speak of first some notable qualities wherewith some of them are endued: Secondly, The remarkable



uses they are of to us. The qualities I shall instance in are: First, *Colour*, which in some of them is most lively, sparkling, and beautiful; the *Carbuncle*, or *Rubine* shining with red, the *Saphire* with blue, the *Emerald* with green, the *Topaz*, or *Chrysolite of the ancients*, with a yellow, or gold colour, the *Amethyst* as it were tinctured with wine, the *Opal* varying its colours like changeable *Taffata*, as it is diversly exposed to the light. Secondly, *Hardness*, wherein some stones exceed all other bodies, and among them the *Adamant* all other stones, being exalted to that degree thereof, that art in vain endeavours to counterfeit it, the fictitious stones of chymists in imitation being easily detected by an ordinary lapidist. Thirdly, *Figure*: Many of them shoot into regular figures, as *Crystal* and *Bastard Diamonds* into hexagonal; others into those that are more elegant and compounded, as those formed in imitation of the shells of Testaceous fishes of all sorts, Sharks teeth and Vertebres, &c. if these be originally stones, or primary productions of nature in imitation of shells, and fishes bones, and not the shells and bones themselves petrified, as we have sometimes thought. Some have a kind of vegetation and resemblance of plants, as *Corals*, *Pori*, and *Fungites*, which grow upon the rocks like shrubs: To which I might add our ordinary *Star-Stones* and *Frochites*, which I look upon as a sort of Rock-plants.

Secondly, For the uses; some serve for building, and many sorts of vessels and utensils; for Pillars and statues, and other carved works in *relievo*, for the temples, ornament of palaces, portico's, piazza's, conduits, &c. as freestone and marble; some to burn into lime, as chalk and lime-stone; some, with the mixture of *Beriglia* or *Kelp*, to make glass, as that the *Venetians* call *Congulo*, and

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common flints, which serve also to strike fire;  
 some to cover houses, as slates, some for marking,  
 as *Morochthus*, and the fore-mentioned chalk,  
 which is a *πολύχρυσον*, serving moreover for manu-  
 ring land, and some medicinal uses; some to  
 make vessels of which will endure the fire, as that  
 found in the country of *Chiavenna* near *Plurs*. To  
 these useful stones I might add the *Warming-stone*,  
 digged in *Cornwall*, which being once well heated  
 at the fire, retains its warmth a great while, and  
 hath been found to give ease and relief in several  
 pains and diseases, particularly in that of the in-  
 ternal haemorrhoids. I might also take notice,  
 that some stones are endued with an *electrical* or  
 attractical virtue. "My honoured friend, Dr.  
 " *Tancred Robinson*, in his manuscript *Itinerary*  
 " of *Italy*, relates the many various figures he  
 " observed naturally delineated and drawn of seve-  
 " ral sorts of stones digged up in the quarries,  
 " caverns and rocks about *Florence*, and other  
 " parts of *Italy*, not only representing cities,  
 " mountains, ruins, clouds, oriental characters,  
 " rivers, woods, animals, but also some plants  
 " (as ivy, mosses, maidenhair, ferns, and such  
 " vegetables as grow in those places) so exactly  
 " designed and impressed upon several kinds of  
 " stones, as though some skilful painters or sculp-  
 " tors had been working upon them. The *Doctor*  
 " observes also the wonderful diversity of shapes  
 " and colours that oars and other fossils shoot  
 " into, resembling almost every thing in nature,  
 " for which it seems very difficult to him to assign  
 " any cause or principle. In the *Pyrites* alone he  
 " believes he himself may have seen at home and  
 " abroad above a hundred varieties, and yet he  
 " confesses he has been but a rude observer of  
 " them. In the diaphanous fossils (as ambers,  
 " crystals, agates, &c.) preserved in the cabinets

"of the great duke of *Tuscany*, cardinal *Chigi*,  
 " *Settali Moscardi*, and other repositories or  
 " museums of that curious country, he takes  
 " notice of the admirable diversity of bodies in-  
 " cluded and naturally imprisoned within them,  
 " as flies, spiders, frogs, locusts, bees, pismires,  
 " gnats, grasshoppers, drops of liquor, hair, leaves,  
 " rushes, moss, seeds, and other herbage; which  
 " seem to prove them to have been one in a  
 " state of fluidity. The *Bononia* stone digged  
 " up in the *Appenines* is remarkable for its shin-  
 " ing quality. The *Amianthus* for its incom-  
 " bustibility. The *Oculus Mundi* for its motion  
 " and change of colour. The *Lapis Nephriticus*,  
 " *Calaminaris*, *Ostiocolla*, *Ætites*, &c. for their  
 " medicinal uses."

I might spend much time in the discoursing of  
 the most strange and unaccountable nature and  
 power of the loadstone, a subject which hath ex-  
 ercised the wits and pains of the most acute and  
 ingenious philosophers; and yet the *Hypotheses*  
 which they have invented to give an account of its  
 admirable *Phænomena* seem to me lame and un-  
 satisfactory. What can we say of the subtilty,  
 activity, and penetracy of its *Effluvia*, which no  
 obstacle can stop or repel, but they will make their  
 way thro' all sorts of bodies, firm and fluid, dense  
 and rare, heavy and light, pellucid and opaque. I  
 say, they will pass thro' a vacuity or empty space,  
 at least devoid of air and any other sensible body.  
 Its attractive power of iron was known to the an-  
 cients. Its verticity and direction to the poles  
 of the earth is of later invention; which, of how  
 infinite advantage it hath been to these two or  
 three last ages, the great improvement of naviga-  
 tion, and advancement of trade and commerce,  
 by rendring the remotest countries easily accessible;  
 the noble discovery of a vast continent or new  
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world, besides a multitude of unknown kingdoms and islands; the resolving experimentally those ancient problems of the spherical roundness of the earth; of the being of *Antipodes*, or the habitableness of the *Torrid Zone*; and the rendring the whole terraqueous globe circumnavigable, do abundantly demonstrate: Whereas formerly they were wont to coast it, and creep along the shores, scarce daring to venture out of the ken of land: when they did, having no other guide but the *Cynosura*, or pole-star, and those near it, and in cloudy weather none at all.

As for *Metals*, they are so many ways useful to mankind, and those uses so well known to all, that it would be lost labour to say any thing of them: Without the use of these we could have nothing of culture or civility; no tillage or agriculture no reaping or mowing; no ploughing or digging; no pruning or lopping, grafting, or incision; no mechanical arts or trades; no vessels or utensils of household-stuff; no convenient houses or edifices; no shipping or navigation. What a kind of barbarous and sordid life we must necessarily have lived, the *Indians* in the northern part of *America* are a clear demonstration. Only it is remarkable, that those which are of most frequent and necessary use, as iron, brass, and lead, are the most common and plentiful: Others that are more rare, may better be spared, yet are they thereby qualified to be made the common measure and standard of the value of all other commodities, and so serve for coin or money, to which use they have been employed by all civil nations in all ages.

Now of what mighty importance the use of money is to mankind, the learned and ingenious Dr. Cockburn shews us, in the *Second part* of his *essay concerning the Nature of Christian Faith*, p.

88. Whenever, saith he, the use of money began, it was an admirable contrivance for rewarding and encouraging industry, for carrying on trade and commerce certainly, easily, and speedily; for obliging all to employ their various parts and several capacities for the common good, and engaging every one to communicate the benefit of his particular labour, without any prejudice to himself. Covetousness indeed, or an inordinate love of money, is vicious, and the root of much evil, and ought to be remedied; but the use of money is necessary, and attended with manifold advantages. Where money has not yet taken place, where the use of it hath not yet been introduced, arts and sciences are not cultivated, nor any of those exercises plyed, which polite men's spirits and which abate the uneasiness of life. Men there are brutish and savage, none mind any thing but eating and drinking, and the other acts of brutish nature; their thoughts aspire no higher than merely to maintain their life and breath: Like the beasts they walk abroad all the day long, and range about from place to place, only to seek their food. Whatever may be supposed to follow if all were acted with great generosity and true charity, yet, according to the present temper of mankind, it is absolutely necessary that there be some method and means of commutation, as that of money, for rendring ail and every one mutually useful and serviceable.

Now gold and silver by their rarity are wonderfully fitted and accommodated for this use of permutation for all sorts of commodities, or making money of: Whereas were they as common and easy to come by as straw or stubble, sand or stones, they would be of no more use for bartering and commerce than they.

And here he goes on to shew the wonderful pro-  
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vidence of God, in keeping up the value of gold and silver, notwithstanding the vast quantities which have been digged out of the earth in all ages, and so continuing them a fit material to make money of. For which I refer to the book.

Of these, Gold is remarkable for its admirable ductility and ponderosity, wherein it excels all other bodies hitherto known. I shall only add, concerning metals, that they do pertinaciously resist all transmutation ; and tho' one would sometimes think they were turned into a different substance, yet do they but as it were lurk under a *Larva* or vizard, and may be reduced again into their natural form and complexions, in despite of all the tortures of *Vulcan* or corrosive waters. Note, *That this was written above thirty years since, when I thought I had reason to distrust whatever had then been reported or written to affirm the transmutation of metals one into another.*

I shall omit the consideration of other minerals, and of salts and earths, because I have nothing to say of their uses, but only such as refer to man, which I cannot affirm to have been the sole or primary end of the formation of them. Indeed, to speak in general of these terrestrial inanimate bodies, they having no such organization of parts as the bodies of animals, nor any so intricate variety of texture, but that their production may plausibly be accounted for by an *Hypothesis* of matter divided into minute particles or atoms naturally indivisible, of various but a determinate number of figures, and perhaps also differing in magnitude, and these moved, and continually kept in motion according to certain established laws or rules ; we cannot so clearly discover the uses for which they were created, but may probably conclude, that among other ends they were made for those for which they serve us and other animals ; as I shall more fully



fully make out hereafter. It is here to be noted, that, according to our *Hypothesis*, the number of the atoms of each several kind that is of the same figure and magnitude is not nearly equal, but there be infinitely more of some species than of others, as of those that compound those vast aggregates of *Air*, *Water*, and *Earth*, more abundantly than of such as make up *Metals* and *Minerals*: The reason whereof may probably be, because those are necessary to the life and being of man and all other animals, and therefore must be always at hand; these only useful to man, and serving rather his conveniences than necessities. The reason why I affirm the minute component particles of bodies to be naturally indivisible by any agent we can employ, (even fire itself) which is the only Catholick dissolvent, other *Menstruums* being rather instruments than efficient in all solutions, apt by reason of the figure and smallness of their parts to cut and divide other bodies (as wedges cleave wood) when actuated by fire or its heat, which else would have no efficacy at all (as wedges have not, unless driven by a beetle :) The reason, I say, I have already given; I shall now instance in a body whose minute parts appear to be indissoluble by the force of fire, and that is common water, which distil, boil, circulate, work upon how you will by fire, you can only dissolve it into vapour, which when the motion ceases, easily returns into water again; vapour being nothing else but the minute parts thereof, by heat agitated and separated one from another, For another instance, some of the most learned and experienced chymists do affirm quicksilver to be intransmutable, and therefore call it *Liquor aeternus*. And I am of opinion, that the same holds of all simple bodies, that their component particles are indissoluble by any natural agent.

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We may here note the order and method that metals and minerals observe in their growth, how regularly they shoot; ferment and as it were vegetate and regenerate; salts in their proper and constant figures, as our ingenious country-man Dr. *Jordan* observes at large in his discourse of baths and mineral waters.

*Of Vegetables or plants.*

I have now done with inanimate bodies both simple and mixed. The animate are,

First, Such as are endued only with a vegetative soul, and therefore commonly call'd *Vegetables* or *Plants*; of which, if we consider either their stature and shape, or their age and duration, we shall find it wonderful; for why should some plants rise up to a great height, others creep upon the ground, which perhaps may have equal *Seeds*? nay, the lesser plant many times the greater seed! Why should each particular so observe its kind, as constantly to produce the same leaf for consistency, figure, division and edging, and bring forth the same kind of flower, and fruit and seed? and that tho' you translate it into a soil which naturally puts forth no such kind of plant, so that it is some \* *λογος σπριματικος*, which doth <sup>• Seminal Form or Virtue.</sup> effect this, or rather some intelligent *plastick Nature*; as we have before intimated: For what account can be given of the determination of the growth and magnitude of plants from mechanical principles, of *matter moved* without the presidency and guidance of some superior agent? Why may not trees grow up as high as the clouds or vapours ascend? Or if you say the cold of the superior air checks them, Why may they not spread and extend their lateral branches so far till their distance from the centre of gravi-

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ty depress them to the earth, be the tree never so high? How comes it to pass that tho' by culture and manure they may be highly improved, and augmented to a double, treble, nay, some a much greater proportion in magnitude of all their parts, yet is this advance restrained within certain limits? There is *maximum quod sic* which they cannot exceed. You can by no culture or art extend a *Fennel-stalk* to the stature and bigness of an *Oak*. Then why should some be very long-lived, others only annual or biennial? How can we imagine that any laws of motion can determine the *Situation* of the *Leaves*, to come forth by pairs or alternately, or circling the stalk; the *Flowers* to grow singly, or in company and tufts, to come forth the bosoms of leaves and branches, or on the tops of branches and stalks; the *Figure* of the leaves, that they should be divided into so many jags or escallops, and curiously indented round the edges; as also of the flower-leaves, their number and site, the figure and number of the *Stamina* and the *Apices*, the figure of the *Stile* and seed-vessel, and the number of cells into which it is divided? That all this be done, and all these parts duly proportioned one to another, there seems to be necessary some intelligent *plastic Nature*, which may understand and regulate the whole oeconomy of the plants: For this cannot be the vegetative soul, because that is material and divisible together with the body; which appears, in that a branch cut off of a plant will take root, and grow, and become a perfect plant itself, as we have already observed. I had almost forgotten the complication of the seed leaves of some plants in the seed, which is so strange, that one cannot believe it to be done by matter, however moved by any laws or rules imaginable. Some of them being so close-plaited, and straitly folded

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folded up and thrust together within the membranes of the seed, that it would puzzle a man to imitate it, and yet none of the folds sticking or growing together; so that they may easily be taken out of their cases, and spread and extended even with one's fingers.

Secondly, If we consider each particular part of a plant, we shall find it not without its end or use; the *Root*, for its stability and drawing nourishment from the earth; the *Fibres* to contain and convey the sap; besides which, there is a large sort of vessels to contain the proper and specifick juice of the plant, and others to carry air for such a kind of respiration as it needeth; of which we have already spoken. The outer and inner bark in trees serve to defend the trunk and boughs from the excesses of heat and cold, and drought, and to convey the sap for the annual augmentation of the tree; for in truth, every tree may in some sense be said to be an annual plant, both leaf, flower and fruit proceeding from the coat that was superinduced over the wood last year, which coat also never beareth any more, but together with the old wood serves as a form or block to sustain the succeeding annual coat. The *Leaves* before the *Gemma* or bud be explicated to embrace and defend the flower and fruit, which is even then perfectly formed; afterwards to preserve the branches, flowers and fruit from the injuries of the Summer-sun, which would too much parch and dry them, if they lay open and exposed to its beams without any shelter: The leaves, I say, qualify and temper the heat, and serve also to hinder the too hasty evaporation of the moisture about the root: But the principal use of the leaves (as we learn of Signior *Malphigii*, Mons. *Perault*, and Mons. *Marriotte*) is to concoct and prepare the sap for the nourishment of the fruit.

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and the whole plant, not only that which ascends from the root, but what they take in from without, from the dew, moist air and rain. This they prove, because many trees if despoil'd of their leaves, will die; as it happens sometimes in *Mulberry-trees* when they are plucked off to feed *Silk-worms*. And because if in Summer-time you denude a vine-branch of its leaves, the grapes will never come to maturity: But tho' you expose the grapes to the sun-beams, if you pluck not off the leaves, they will ripen notwithstanding. That there is a regrefs of the sap in plants from above downwards, and that this descendent juice is that which principally nourisheth both fruit and plant, is clearly proved by the experiments of Signior *Malphigi*, and those late ones of an ingenious country-man of our own,

† Philosoph.  
T. aniaet.  
Num. 187.

† *Thomas Brotherton* Esquire, of which I shall mention only one, that is, If you cut off a ring of bark from the trunk of any tree, that part of the tree above the barked ring shall grow and increase in bigness, but not that beneath.

But whether there be such a constant circulation of the sap in plants as there is of the blood in animals, as they would from hence infer, there is some reason to doubt. I might add hereto the pleasant and delectable cooling and refreshing shade they afford in the Summer-time; which was very much esteemed by the inhabitants of hot countries, who always took great delight and pleasure to sit in the open air, under shady trees. Hence that expression so often repeated in scripture, of every man's *sitting under his own vine, and under his own Fig-tree* where also they used to eat; as appears by *Abraham's* entertaining the angels under a tree, and standing by them when they did eat, *Gen. xviii. 8*. Moreover, the leaves of plants

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*More* and others well observe. The adorning and  
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taking in leaves and flowers and fruitage for the  
garnishing of their work; as the *Roman* the leaves  
of *Achanthus sat.* and the *Juice* of *Palm-trees*  
and *Pomegranats*? And these more frequently than  
any of the five regular solids, as being more come-  
ly and pleasant to behold. If any man shall ob-  
ject, that comeliness of proportion and beauty is  
but a mere conceit, and that all things are alike  
handsome to men who have as good eyes as others;  
and that this appears by the variation of fashions,  
which doth so alter men's fancies, that what e're-  
while seemed very handsome and comely, when it  
is once worn out of fashion appears very absurd,  
uncouth and ridiculous. To this I answer, That  
custom and use doth much in those things where  
little of proportion and symmetry shew themselves,  
or which are alike comely and beautiful, to dis-  
parage the one, and commend the o-  
ther: But there are degrees of things;  
for (that I may use || Dr. *More's* || Antidote  
words) I dare appeal to any man that against A-  
is not sunk into so forlorn a pitch of theism, 1.  
degeneracy, that he is as stupid to these things as 2. c. 5.  
the basest beasts, whether, for example, a rightly-  
cut *Tetrædrom*, *Cube* or *Icosædrom* have no more  
pulchritude in them than any rude broken stone  
lying in the field or high-ways; or, to name other  
solid figures, which tho' they be not regular, pro-  
perly so called, yet have a settled *Idea* and nature,  
as a *Cone*, *Sphere* or *Cylinder*, whether the sight  
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of those do not more gratify the minds of men, and pretend to more elegancy of shape, than those rude cuttings or chippings of free-stone that fall from the mason's hands, and serve for nothing but to fill up the middle of the wall, as fit to be hid from the eyes of men for their ugliness? And therefore it is observable, that if nature shape any thing but near to this *Geometrical Accuracy*, that we take notice of it with much content and pleasure, and greedily gather and treasure it up. As if it be but exactly round, as those spherical stones found in *Cuba*, and some also in our own land; or have but its sides parallel, as those rhomboideal *Selenites* found near *St. Ives* in *Huntingtonshire*, and many other places in *England*. Whereas ordinary stones of rude and uncertain figures we pass by, and take no notice of at all. But tho' the figures of these bodies be pleasing and agreeable to our minds, yet (as we have already observed) those of the leaves, flowers and fruits of trees, more. And it is remarkable, that in the circumscription and complication of many leaves, flowers, fruits, and seeds, nature affects a regular figure. Of a pentagonal or quincunial disposition, Sir *Thomas Brown* of *Norwich* produces several examples in his discourse about the *Quicunx*. And doubtless instances might be given in other regular figures, were men but observant.

The *Flowers* serve to cherish and defend the first and tender rudiments of the fruit; I might also add the masculine or prolific seed contained in the chives or *Apices* of the *Stamina*. These, besides the elegancy of their figures, are many of them endued with splendid and lovely colours, and likewise most grateful and fragrant odours. Indeed such is the beauty and lustre of some flowers, that our Saviour saith of the lillies of the fields

fields (which some, not without reason, suppose to have been *Tulips*) that *Solomon in all his glory was not arrayed like one of these*. And it is observed by \* *Spigelius*, That the art of the most skilful painter cannot so mingle and temper his colours, as exactly to imitate or counterfeit the native ones of the flowers of *Vegetables*.

\* *Isag. ad rem Herbariam.*

As for the *Seeds of Plants*, † Dr. More esteems it an evident sign of divine providence, that every kind hath its seed: For it being no necessary result of the motion of the matter, (as the whole contrivance of the plant indeed is not) and it being of so great consequence that they have seed for the continuance and propagation of their own species, and also for the gratifying man's art, industry and necessities, (for much of husbandry and gardening lies in this) it cannot but be an act of counsel to furnish the several kinds of plants with their seeds.

† Antidote against Atheism, L. 2. c. 2.

Now the *Seed* being so necessary for the maintenance and increase of the several *Species*, it is worthy the observation, what care is taken to secure and preserve it, being in some doubly and trebly defended. As for instance, in the *Walnut*, *Almond* and *Plumbs* of all sorts; we have first a thick pulpy covering, then a hard shell, within which is the seed enclosed in a double membrane. In the *Nutmeg* another tegument is added besides all these, viz. the *Mace* between the green *Pericarpium* and the hard shell, immediately inclosing the kernel. Neither yet doth the exterior pulp of the fruit or *Pericarpium* serve only for the defence and security of the seed whilst it hangs upon the plant, but after it is mature and fallen upon the earth, for the stercoration of the soil and promotion of the growth, tho' not the first germination

\* Agric. l. 2.  
c. 6.

of the seminal plant. Hence (as \* *Petrus de Crescentiis* tells us) husbandmen, to make their vines bear, manure them with vine leaves, or the husks of expressed grapes; and they observe those to be most fruitful which are so manured with their own; which observation holds true also in all other trees and herbs. But besides this use of the pulp or *Pericarpium* for the guard and benefit of the seed, it serves also by a secondary intention of nature in many fruits for the food and sustenance of man and other animals.

Another thing worthy the noting in *Seeds*, and argumentative of providence and design, is that papose plumage growing upon the tops of some of them, whereby they are capable of being waisted with the wind, and by that means scattered and disseminated far and wide.

Furthermore, most *Seeds* having in them a seminal plant perfectly formed, as the young is in the womb of animals, the elegant complication thereof in some *Species* is a very pleasant and admirable spectacle; so that no man that hath a soul in him can imagine or believe it was so formed and folded up without wisdom and providence. But of this I have spoken already.

Lastly, The immense smallness of some seeds, not to be seen by the naked eye, so that the number of seeds produced at once in some one plant, as for example, *Reedmace* [*Tipho Palustris*] *Hartstongue*, and many sorts of *Ferns*, may amount to a million, is a convincing argument of the infinite understanding and art of the Former of them.

And it is remarkable that such *Mosses* as grow upon walls, the roofs of houses, and other high places, have seeds so excessively small, that when shaken out of their vessels they appear like vapour or smoke, so that they may either ascend of themselves,



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selves, or by any easy impulse of the wind be raised up to the tops of houses, walls or rocks; and we need not wonder how the mosses got thither, or imagine they sprung up spontaneously there.

I might also take notice of many other particulars concerning vegetables, as, First, that because they are designed for the food of animals, therefore nature hath taken more extraordinary care, and made more abundant provision of their propagation and increase; so that they are multiplied and propagated not only by the seed, but many also by the root, producing off-sets, or creeping under ground; many by strings or wyres running above ground, as *Strawberry*, and the like, some by slips and cuttings, and some by several of these ways. And for the security of such *Species* as are produced only by seed, it hath endued all seed with a lasting vitality, that so if by reason of excessive cold or drought, or any other accident, it happen not to germinate the first year, it will continue its foecundity, I do not say two or three, nor six or seven, but even twenty or thirty years, and when the impediment is removed, the earth in fit case, and the season proper, spring up, bear fruit, and continue its species. Hence it is that plants are sometimes lost for a while in places where they formerly abounded, and again after some years appear new; lost, either because the springs were not proper for their germination, or because the land was fallowed, or because plenty of weeds or other herbs prevented their coming up, or the like; and appearing again when these impediments are removed. Secondly, That some sorts of plants, as *Vines*, all sorts of *Pulse*, *Hops*, *Briony*, all pomiferous herbs, *Pumpions*, *Melons*, *Gourds*, *Cucumbers*, and divers others *Species*, that are weak and unable to raise or support themselves, are either endued with a faculty of twining about

others that are near, or else furnished with claspers and tendrils, whereby, as it were with hands, they catch hold of them, and so ramping upon trees, shrubs, hedges or poles, they mount up to a great height, and secure themselves and their fruit. Thirdly, That others are armed with prickles and thorns, to secure them from the browsing of beasts, as also to shelter others that grow under them; moreover, they are hereby rendered very useful to man, as if designed by nature to make both quick and dead hedges and fences. The great naturalist *Pliny* hath given an ingenious account of the providence and design of nature in thus arming and fencing them in these words: *Inde* (speaking of nature) *excogitavit aliquas aspectu hispidas, tactu truces, ut tantum non vocem ipsius naturæ fingentis illas, rationemque reddentis exaudire videamur, ne se depascat avida quadrupes, ne procaces manus rapiant, ne neglecta vestigia obterant, ne insidens ales infringat; his muniendo aculeis telisque, remediis ut salva acuta sint. Ita hoc quoque quod in iis odimus, hominum causa excogitatum est.*

It is worthy the noting, that *Wheat*, which is the best sort of grain, of which the purest, most savoury and wholesome bread is made, is patient of both extremes, heat and cold, growing and bringing its seed to maturity not only in temperate countries, but also on one hand in the cold and northern, viz. *Scotland, Denmark &c.* on the other, in the hottest and most southerly, as *Egypt, Barbary, Mauritania, the East-Indies, Guiney, Madagascar, &c.* scarce refusing any climate.

Nor is it less observable, and not to be commemorated without acknowledgement of the divine Benignity to us, that (as *Pliny* rightly notes) nothing is more fruitful then *Wheat*, *Quod ei natura* (saith he) [*rectius naturæ parens*] *tribuit quod eo maxime*

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*maxime hominem alit, utpote cum e modio, si & ap-  
tum solum, quale in Byzacio Africae campo centeni  
quingenta modii reddentur. Misit ex eo loco Divo  
Augusto procurator ejus ex uno grano (vix credibilis  
dictu) 400 paucis minus germina: Misit & Neroni  
similiter 360 stipulas ex uno grano.* "Which fer-  
tility nature, (he should have said, the author  
of nature) hath conferred upon it, because it  
feeds man chiefly with it. One bushel, if sown  
in a fit and proper soil, such as is *Byzachium*, a  
field of *Africa*, yielding 150 of annual increase.  
Augustus's Procurator sent him from that place  
400 within a few blades springing from the same  
grain: And to *Nero* were sent thence 360." If  
*Pliny*, a heathen, could make this fertility of  
wheat argumentative of the bounty of God to man,  
making such plentiful provision for him: of that  
which is of most pleasant taste and wholesome nou-  
rishment, surely it ought not to be passed over by us  
*Christians* without notice taking and thanksgiving.

As for the signatures of plants, or the notes  
impressed upon them, as *Indioes* of their  
virtues, though \* some lay great stress  
upon them, accounting them strong  
arguments to prove, that some under-  
standing principle is the highest original of the  
works of nature, as indeed they were, could it  
certainly be made appear, that there were such  
marks designedly set upon them; because all that I  
find mentioned and collected by authors, seem to  
me to be rather fancied by men, than designed by  
nature to signify or point out any such virtues or  
qualities as they would make us believe. I have  
elsewhere, I think upon good grounds, rejected  
them: And finding no reason, as yet, to alter my  
opinion, I shall not further insist on them: How-  
beit, I will not deny, but that the noxious and ma-  
lignant plants do many of them discover something  
of

\* Dr. More  
Antid. l. 2.  
c. 6.



of their nature by the sad and melancholick visage of their leaves, flowers and fruit. And that I may not leave that head wholly untouched, one observation I shall add relating to the virtues of plants, in which I think there is something of truth; that is, that there are, by the wise disposition of providence, such *Species* of plants produced in every country, as are most proper and convenient for the meat and medicine of the men and animals that are bred and inhabit there: Infomuch that *Solander* writes, that from the frequency of the plants that sprung up naturally in any region, he could easily gather what endemial diseases the inhabitants thereof were subject to: So in *Denmark*, *Friesland*, and *Holland*, where the scurvy usually reigns, the proper remedy thereof, *Scurvy Grass*, doth plentifully grow.

*Of Bodies endued with a sensitive Soul, or Animals.*

I proceed now to the consideration of animate bodies endued with a sensitive soul, called *Animals*. Of these I shall only make some general observations, not curiously consider the parts of such particular *Species*, save only as they serve for instances or examples.

First of all, because it is the great design of providence to maintain and continue every species, I shall take notice of the great care and abundant provision that is made for the securing this end. *Quanta ad eam rem vis, ut in suo quæque genere permaneat?* Cic. Why can we imagine all creatures should be made male and female but to this purpose? Why should there be implanted in each sex such a vehement and inexpugnable appetite of copulation? Why in viviparous animals, in the time of gestation, should the nourishment be carried to the *Embryon* in the womb, which at other  
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times goeth not that way? When the young is brought forth, how comes all the nourishment then to be transferred from the womb to the breast or paps, leaving its former channel, the dam at such time being for the most part lean and ill-favoured? To all this I might add, as a great proof and instance of the care that is taken, and provision made for the preservation and continuance of the species, the lasting foecundity of the animal seed or egg in the females of man, beasts and birds. I say, the animal seed, because it is to me highly probable, that the females, as well of beasts as birds, have in them from their first formation the seeds of all the young they will afterwards bring forth, which when they are all spent and exhausted by what means soever, the animal becomes barren and effete. These seeds in some species of animals continue fruitful, and apt to take life by the admixture of the male-seed fifty years or more, and in some birds fourscore or an hundred. Here I cannot omit one very remarkable observation I find in Cicero: *Atque ut intelligamus* (saith he) *nihil horum esse fortuitum, sed hæc omnia providæ solertisque naturæ, quæ multiplices fœtus procreant, ut sues ut canes, his mammarum data est multitudo, quas easdem paucas habent eæ bestię quæ pauca gignunt.* That we may understand that none of these things (he had been speaking of) is fortuitous, but that all are the effects of provident and sagacious nature; multiparous quadrupeds, as swine and dogs, are furnished with a multitude of paps: Whereas those beasts which bring forth few, have but a few.

That flying creatures of the greater sort, that is, *Birds*, should all lay eggs, and none bring forth live young, is a manifest argument of divine providence, designing thereby their preservation and security, that there might be the more plenty

plenty of them; and that neither the birds of prey, the serpent, nor the fowler, should straiten their generation too much: For if they had been viviparous, the burden of their womb, if they had brought forth any competent number at a time, had been so great and heavy, that their wings would have failed them, and they become an easy prey to their enemies: Or, if they had brought but one or two at a time, they would have been troubled all the year long with feeding their young, or bearing them in their womb. *Dr. More Antid. against Atheism, l. 2. c. 9.*

This mention of feeding their young puts me in mind of two or three considerable observations referring thereto.

First, Seeing it would be for many reasons inconvenient for birds to give suck, and yet no less inconvenient, if not destructive, to the chicken upon exclusion, all of a sudden, to make so great a change in its diet, as to pass from liquid to hard food, before the stomach be gradually consolidated, and by use strengthened and habituated to grind and concoct it, and its tender and pappy flesh fitted to be nourished by such strong and solid diet, and before the bird be by little and little accustomed to use its bill, and gather it up; which at first it doth but very slowly and imperfectly; therefore nature hath provided a large yolk in every egg, a great part whereof remaineth after the chicken is hatched; and is taken up and enclosed in its belly, and, by a channel made on purpose, received by degrees into the guts, and serves instead of milk to nourish the chick for a considerable time; which nevertheless mean while feeds itself by the mouth a little at a time, and gradually more and more, as it gets a perfecter ability and habit of gathering up its meat, and its stomach is strengthened

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thened to macerate and concoct it, and its flesh hardened and fitted to be nourished by it.

Secondly, That birds which feed their young in the nest, tho' in all likelihood they have no ability of counting the number of them, should yet (tho' they bring but one morsel of meat at a time, and have no fewer (it may be) than seven or eight young in the nest together, which at the return of their dams, do all at once with equal greediness, hold up their heads and gape) not omit or forget one of them, but feed them all; which, unless they did carefully observe and retain in memory which they had fed, which not, were impossible to be done: This, I say, seems to me most strange and admirable, and beyond the possibility of a mere machine to perform.

Another experiment I shall add, to prove that tho' birds have not an exact power of numbring, yet have they of distinguishing many from few, and knowing when they come near to a certain number: And that is, that when they have laid such a number of *eggs*, as they can conveniently cover and hatch, they give over and begin to sit; not because they are necessarily determined to such a number; for that they are not, is clear, because they are in ability to go on and lay more at their pleasure. Hens, for example, if you let their *eggs* alone, when they have laid fourteen or fifteen, will give over and begin to sit; whereas, if you daily withdraw their *eggs*, they will go on to lay five times that number: [Yet some of them are so cunning that if you leave them but one *egg*, they will not lay to it, but forsake their nest.] This holds not only in domestick and mansuete birds, for then it might be thought the effect of cicuration or institution, but also in the wild; for my honoured friend Dr. *Martin Lister* informed me, that of his own knowledge one and the same

*Swallow,*

*Swallow*, by the subtracting daily of her *eggs* proceeded to lay nineteen successively, and then gave over as I have \* elsewhere noted.

\*Preface to  
Mr. Willough-  
by's Ornithol.

Now that I am upon this subject of the number of *eggs*, give me leave to add a remarkable observation referring thereto, *viz.* That birds, and such oviparous creatures, as are long-lived, have *Eggs* enough at first conceived in them to serve them for many years lying, probably for as many as they are to live, allowing such a proportion for every year, as will serve for one or two incubations; whereas insects, which are to breed but once, lay all their *eggs* at once, have they never so many. Now, had these things been governed by chance, I see no reason why it should constantly fall out so.

Thirdly, The marvellous speedy growth of birds that are hatched in nests, and fed by the old ones there, till they are fledged, and come almost to their full bigness, at which perfection they arrive within the short term of about one fortnight, seems to me an argument of providence, designing thereby their preservation, that they might not lie long in a condition exposed to the ravine of any vermine that may find them, being utterly unable to escape or shift for themselves.

Another and no less effectual argument may be taken from the care and providence used for the hatching and rearing their young: And first, they search out a secret and quiet place where they may be secure and undisturbed in their incubation: then they make themselves nests every one after his kind, that so their *eggs* and *young* may lie soft and warm, and their exclusion and growth be promoted. These nests are some of them so elegant and artificial, that it is hard for man to imitate them and make the like. I have seen nests of an *Indian* bird so artificially composed of the fibres,

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Part I.  
I think, of some roots, so curiously interwoven and platted together, as is admirable to behold: Which nests they hang on the ends of twigs of trees over the water, to secure their Eggs and Young from the ravage of *Apes* and *Monkeys*, and other beasts, that might else prey upon them. After they have laid their Eggs, how diligently and patiently do they sit upon them till they be hatched, scarce affording themselves time to go off to get them meat? Nay, with such an ardent and impetuous desire of sitting are they inspired, that if you take away all their Eggs, they will sit upon an empty nest: And yet one would think that sitting were none of the most pleasant works. After their young are hatched, for some time they do almost constantly brood them under their wings, lest the cold and sometimes perhaps the heat should harm them. All this while also they labour hard to get them food, sparing it out of their own bellies, and pining themselves almost to death rather than they should want. Moreover, it is admirable to observe with what courage they are at that time inspired, that they will even venture their own lives in defence of them. The most timorous, as *Hens* and *Geese*, become then so courageous, as to dare to fly in the face of a man that shall molest or disquiet their young, which would never do so much in their own defence. These things being contrary to any motions of sense, or instinct of self-preservation, and so eminent pieces of self-denial, must needs be the works of providence, for the continuation of the species, and upholding of the world: Especially if we consider that all that pains is bestowed upon a thing which takes no notice of it, will render them no thanks for it, nor make them any requital, or amends; as also, that after the Young is come to some growth, and able to shift for itself, the

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old one retains no such copy to it, takes no further care of it, but will fall upon it, and beat it indifferently with others. To these I shall add three observations more relating to this head. The first borrowed of Dr. Cudworth, System, p. 69. One thing necessary to the conservation of the species of animals, that is, the keeping up constantly in the world a due numerical proportion between the sexes of *Male* and *Female*, doth necessarily infer a superintending providence. For did this depend only upon Mechanism, it cannot well be conceived, but that in some ages or other there should happen to be all *Males*, or all *Females*, and so the species fail. Nay, it cannot well be thought otherwise, but that there is in this a providence, superior to that of the *Plastick* or *Spermatick Nature*, which hath not so much of knowledge and discretion allowed to it, as whereby to be able to govern this affair.

The second of Mr. Boyle in his treatise of the *high veneration man's intellect owes to God*, p. 32. that is, the conveniency of the season (or time of year) of the production of animals, when there is proper food and entertainment ready for them. *So we see, that, according to the usual course of nature, lambs, kids, and many other living creatures, are brought into the world at the spring of the Year; when tender grass, and other nutritive plants, are provided for their food. And the like may be observed in the production of Silk-worms, (yea, all other Eruca's and many insects more) whose eggs, according to nature's institution, are hatched when Mulberry-trees begin to bud, and put forth those leaves, whereon those precious insects are to feed; the aliments being tender, whilst the worms themselves are so, and growing more strong and substantial, as the insects increase in vigour and bulk.* To these I shall add another

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instance, that is, of the *Wasp*, whose breeding is deferred till after the summer-solstice, few of them appearing before *July*: whereas one would be apt to think the vigorous and quickning heat of the sun in the youth of the year should provoke them to generate much sooner: [provoke them, I say, because every wasp's-nest is begun by one great mother-wasp, which over-lives the winter, lying hid in some hollow tree or other *latibulum*;] because then, and not till then, pears, plumbs, and other fruit, designed principally for their food, begin to ripen.

The third is mine own, That all insects which do not themselves feed their young, nor treasure up provision in store for their sustenance, lay their *Eggs* in such places as are most convenient for their exclusion, and where when hatched, their proper food is ready for them: So, for example, we see two sorts of white *Butterflies* fastening their *Eggs* to cabbage-leaves, because they are fit aliment for the *Catterpillers* that come of them; whereas should they affix them to the leaves of a plant improper for their food, such *Catterpillers* must needs be lost, they chusing rather to die than to taste of such plants; for that kind of insect (I mean *Catterpillers*) hath a nice and delicate palate, some of them feeding only upon one particular *Species* of plant, others on divers indeed, but those of the same nature and quality; utterly refusing them of a contrary. Like instances might be produced in the other tribes of insects; it being perpetual in all, if not hindered or imprisoned, electively to lay their *Eggs* in places where they are seldom lost or miscarry, and where they have a supply of nourishment for their young so soon as they are hatched, and need it: Whereas should they scatter them carelessly and indifferently in any place, the greatest part of young would in all likelihood

perish soon after their exclusion for want of food, and so their numbers continually decreasing, the whole species in a few years would be in danger to be lost: Whereas no such thing, I dare say, hath happened since the first creation.

It is here very remarkable, that those insects, for whose young nature hath not made provision of sufficient sustenance, do themselves gather and lay up in store for them. So for example: The

*Bee*, the proper food of whose *\* Eula*  
*\* Bee Mag-* is honey, or perchance *Eristhace*,  
*got.*

(which we english *Bee-bread*) neither of which viands being any where to be found amassed by nature in quantity sufficient for their maintenance, doth herself with unwearied diligence and industry, flying from flower to flower, collect and treasure them up.

To these I shall now add an observation on Mr. *Lewenhoeck's*, concerning the sudden growth of some sorts of insects, and the reason of it.

It is (saith he) a wonderful thing, and worthy the observation, in flesh-flies, that a fly-maggot, in five days space after it is hatched, arrives at its full growth and perfect magnitude. For if to the perfecting of it there were required, suppose a month's time or more, (as in some other maggots is needful) it is impossible that about the Summer-solstice any such flies should be produced, because the fly-maggots have no ability to search out any other food than that wherein they are placed by their dams. Now this food, suppose it be flesh, fish, or the entrails of beasts, lying in the fields, exposed to the hot Sun-beams, can last but a few days in case and condition to be a fit aliment for these creatures, but will soon be quite parched and dried up, and therefore the most wise Creator hath given such a nature and temperament to them, that within a very few days they attain to their  
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just growth and magnitude; whereas on the contrary, other maggots, who are in no such danger of being straitened for food, continue a whole month or more before they give over to eat and cease to grow. He proceeds further to tell us, that some of these *Fly-maggots* which he fed daily with fresh meat, he brought to perfection in four days time; so that he conceives that in the heat of Summer the *Eggs* of a *Fly*, or the *Maggots* contained in them, may in less than a month's space run thro' all their changes, and come to perfect flies, which may themselves lay *Eggs* again.

Secondly, I shall take notice of the various strange insinuations of animals, which will necessarily demonstrate that they are directed to ends unknown to them by a wise superintendent: As, 1. That all creatures should know how to defend themselves and offend their enemies, where their natural weapons are situate, and how to make use of them. A *Calf* will so manage his head as tho' he would push with horns even before they shoot. A *Boar* knows the use of his tusks; a *Dog* of his teeth; a *Horse* of his hoofs; a *Cock* of his spurs; a *Bee* of her sting; a *Ram* will butt with his head; yea, though he be brought up tame, and never saw that manner of fighting. Now, why another animal which hath no horns should not make a shew of pushing, or no spurs, of striking with his legs, and the like, I know not, but that every kind is providentially directed to the use of its proper and natural weapons. 2. That those animals that are weak, and have neither weapons nor courage to fight, are for the most part created swift of foot or wing, and so being naturally timorous, are both willing and able to save themselves by flight. 3. That poultry, partridge, and other birds, should at the first sight know birds of prey, and make sign of it by a peculiar note of

their voice to their young, who presently there-upon hide themselves; that the *Lamb* should acknowledge the *Wolf* its enemy, tho' it had never seen one before, as is taken for granted by most naturalists, and may for ought I know be true, argues the providence of nature, or more truly the God of nature, who for their preservation hath put such an instinct into them. 4. That young animals as soon as they are brought forth should know their food; as for example, such as are nourished with milk presently find their way to the paps, and suck at them; whereas none of those that are not designed for that nourishment ever offer to suck, or seek out any such food. Again, 5. That such creatures as are whole-footed or fin-toed, viz. some birds, and quadrupeds; are naturally directed to go into the water, and swim there, as we see *Ducklings*, tho' hatched and laid by a hen, if she brings them to the brink of a river or pond of water, they presently leave her, and in they go, though they never saw any such thing done before, and tho' the hen clucks and calls, and doth what she can to keep them out. This *Pliny* takes notice of, *Hist. Nat. lib. 10. cap. 55.* in these words, speaking of hens: *Super omnia est anatum ovis subditis atque exclusis admiratio, primo non plane agnoscentis fœtum: Mox incertos ineubitus solícite convocantis: Postremo lamenta circa piscinæ stagna, mergentibus se pullis natura duce.* So that we see every part in animals is fitted to its use, and the knowledge of this use put into them: For neither do any sort of web-footed fowls live constantly upon the land, or fear to enter the water, nor any land-fowl so much as attempt to swim there. 6. Birds of the same kind make their nests of the same material, laid in the same order, and exactly of the same figure; so that by the sight of the nest one may certainly know what bird it belongs

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belongs to; and this they do tho' living in distant countries, and tho' they never saw nor could see any nest made, that is, though taken out of the nest and brought up by hand; neither were any of the same kind ever observed to make a different nest, either for matter or fashion: This, together with the curious and artificial contexture of such nests, and their fitness and convenience for the reception, hatching and cherishing the eggs and young of their respective builders (which we have before taken notice of) is a great argument of a superior author of their and other natures, who hath endued them with these instincts, whereby they are as it were acted and driven to bring about ends which themselves aim not at (so far as we can discern) but are directed to; for (as Aristotle observes) οὐτε τέχνη, οὐτε ζήτησις, οὐτε βουλευτική νοῦν, they act not by art, neither do they enquire, neither do they deliberate about what they do. And therefore, as Dr. Cudworth saith well, they are not masters of that wisdom according to which they act, but only passive to the instincts and impresses thereof upon them. And indeed to affirm that brute animals do all these things by a knowledge of their own, and which themselves are masters of, and that without deliberation and consultation, were to make them to be endued with a most perfect intellect, far transcending that of human reason; whereas it is plain enough that brutes are not above consultation, but below it, and that these instincts of nature in them are nothing but a kind of fate upon them.

The migration of birds from an hotter to a colder country, or a colder to an hotter, according to the seasons of the year, as their nature is, I know not how to give an account of, it is so strange and admirable. What moves them to shift their quarters? You will say, the disagreeableness of the temper of  
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of the air to the constitution of their bodies, or want of food. But how come they to be directed to the same place yearly, tho' sometimes but a little island, the *Solaud-goose* to the *Basse of Edinburgh-frith*, which they could not possibly see, and so it could have no influence upon them that way? The cold or the heat might possibly drive them in a right line from either; but that they should impel land-birds to venture over a wide ocean, of which they can see no end, is strange and unaccountable; one would think that the sight of so much water, and present fear of drowning, should overcome the sense of hunger, or disagreeableness of the temper of the air. Besides, how come they to steer their course aright to their several quarters, which before the compass was invented was hard for a man himself to do, they being not able, as I noted before, to see them at that distance? Think we that the *Quails*, for instance, could see quite cross the *Mediterranean-sea*? And yet it is clear they fly out of *Italy* into *Africa*, lighting many times on ships in the midst of the sea, to rest themselves when tired and spent with flying. That they should thus shift places, is very convenient for them, and accordingly we see they do it; which seems to be impossible they should, unless themselves were endued with reason, or directed and acted by a superior intelligent cause.

The like may be said of the migration of divers sorts of fishes: As for example; the *Salmon*, which from the sea yearly ascends up a river sometimes 400 or 500 miles, only to cast their spawn, and secure it in banks of sand, for the preservation of it till the young be hatched or excluded, and then return to sea again. How these creatures when they have been wandring a long time in the wide ocean, should again find out and repair to the mouths of the same rivers, seems to me very  
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strange, and hardly accountable, without recourse to instinct and the direction of a superior cause. That birds, seeing they have no teeth for the mastication and preparation of their food, should for the more convenient comminution of it in their stomachs or gizzards, swallow down little pebble-stones, or other hard bodies; and because all are not fit or proper for that use, should first try them in their bills, to feel whether they be rough or angular, for their turns, which if they find them not to be, they reject them; when these by the working of the stomach are worn smooth, or too small for their use, they void them by siege, and pick up others; that these are of great use to them for the grinding of their meat, there is no doubt: And I have observed in birds that have been kept up in houses, where they could get no pebbles, the very yolks of their eggs have changed colour, and become a great deal paler than theirs who have their liberty to go abroad.

Besides, I have observed in many birds, the gullet, before its entrance into the gizzard, to be much dilated, and thick set, or as it were granulated, with a multitude of glandules, each whereof was provided with its excretory vessel, out of which, by an easy-pressure, you might squeeze a juice or pap, which served for the same use which the *Saliva* doth in quadrupeds, that is, for the macerating and dissolution of the meat into a chyle; for that the *Saliva*, notwithstanding its insipidness, hath a notable virtue of macerating and dissolving bodies, appears by the effects it hath in killing of quicksilver, fermenting of dough like leaven or yeast, taking away warts, and curing other cutaneous distempers; sometimes exulcerating the jaws, and rotting the teeth.

Give me leave to add one particular more concerning birds, which some may perchance think too home-

homely and indecent to be mentioned in such a discourse as this; yet because it is not below the providence of nature, and designed for cleanliness, and some great men have thought it worth the observing, I need not to be ashamed to take notice of it, that is, that in young birds that are fed in the nest, the excrement that is voided at one time is so viscid, that it hangs together in a great lump, as if it were inclosed in a film, so that it may easily be taken up and carried away by the old bird in her bill; besides, by a strange instinct the young bird elevates her hinder parts so high, for the most part, that she seldom fails to cast what comes from her clear over the side of the nest; so we see here is a double provision made to keep the nest clean, which, if it were defiled with ordure, the young ones must necessarily be utterly marred and ruined.

7. The *Bee*, a creature of the lowest forms of animals, so that no man can suspect it to have any considerable measure of understanding, or to have knowledge of, much less to aim at any end, yet makes her combs and cells with that geometrical accuracy that she must needs be acted by an instinct implanted in her by the wise author of nature; for first she plants them in a perpendicular posture, and so close together as with conveniency they may, beginning at the top and working downwards, that so no room may be lost in the hive, and that she may have easy access to all the combs and cells; besides, the combs being wrought double, that is, with cells on each side, a common bottom or partition wall could not in any other site have so conveniently, if at all, received or contained the honey; then she makes the particular cells most geometrically and artificially, as the famous mathematician *Pappus* demonstrates in the preface to his third book of *Mathematical Collections*. First of all (saith he, speaking of the cells)

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included liquor from spilling, and from external injuries, as Mr. Boyle truly observes, *Treatise of Animal Causes*, p. 169. Another sort of *Bee* I have observed, may be called the *Tree Bee*, whose industry is admirable in making provision for her young. First, she digs round vaults or burrows [*Cuniculos*] in a rotten or decayed tree, of a great length, in them she builds or forms her cylindrical nests or cases, resembling cartridges, or a very narrow thimble, only in proportion longer, of pieces of rose, or other leaves, which she shears off with her mouth, and plats and joins close together by some glutinous substance; these cases she fills with a red pap, of a thinner consistency than an electuary, of no pleasant taste, which where she gathers I know not; and, which is most remarkable, she forms these cases and stores them with this provision before she hath any young one hatched, or so much as an egg laid; for on the top of the pap she lays one egg, and then closes up the vessel with a cover of leaves: The inclosed egg soon becomes an *Eula*, or maggot, which feeding upon the pap till it comes to its full growth, changes to a *Nympha*, and after comes out a *Bee*. Another insect noted for her seeming prudence, in making provision for the Winter, proposed by *Solomon* for our imitation, is the *Ant*, which (as all naturalists agree) hoards up grains of corn against the Winter for her sustenance, and is reported by some to

\* bite off the *germen* of them lest they should sprout by the moisture of the earth, which I look upon as a mere fiction; neither should I be forward to credit the former relation, were it not for the authority of the *Scripture*, because I could never observe any such storing of grain by our country *Ants*.

Yet there is a quadruped taken notice of even by the vulgar, for laying up in store provision for the

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Winter; that is, the *Squirrel*, whose hoards of nuts are frequently found, and pillaged by them.

The *Beaver* is by credible persons, eye-witnesses, affirmed to build him houses for shelter and security in winter-time. See Mr. Boyle of *final Causes*, p. 173.

Besides these I have mentioned, an hundred others may be found in books relating especially to physick: As, that *Dogs* when they are sick, should vomit themselves by eating grass; that *Swine* should refuse meat so soon as they feel themselves ill, and so recover by abstinence; that the bird *Ibis* should teach men the way of administering clysters, *Plin. lib. 8. cap. 27.* the wild *Goats* of *Dictamnus* for drawing out of darts and healing wounds; the *Swallow* the use of *Gelandine* for repairing the sight, &c. *ibid.* Of the truth of which, because I am not fully satisfied, I shall make no inference from them.

Thirdly, I shall remark the care that is taken for the preservation of the weak, and such as are exposed to injuries, and preventing the increase of such as are noisome and hurtful; for as it is a demonstration of the divine power and magnificence to create such variety of animals, not only great but small, not only strong and courageous, but also weak and timorous; so is it no less argument of his wisdom to give to *these* means, and the power and skill of using them, to preserve themselves from the violence and injuries of *those*. That of the weak, some should dig vaults and holes in the earth, as *Rabbits*, to secure themselves and their young; others should be armed with hard shells; others with prickles; the rest that have no such armature, should be endued with great swiftness or perniciousity; and not only so, but some also have their eyes stand so prominent, as the *Hare*, that they can see as well behind as before them, that so they may have their enemy alway in their eye; and



long, hollow, moveable ears, to receive and convey the least sound, or that which comes from far, that they be not suddenly surprized or taken (as they say) napping. Moreover, it is remarkable, that in this animal, and in the *Rabbit*, the muscles of the loins and hind legs are extraordinarily large in proportion to the rest of the body, or those of other animals, as if made on purpose for swiftness, that they may be able to escape the teeth of so many enemies as continually pursue and chase them; add hereto the length of their hind legs, which is no small advantage to them, as is noted by dame *Julan Barns* in an ancient dialogue in verse between the huntsman and his man: The man there asks his master, What is the reason, why the hare when she is near spent makes up a hill? The master answers, That nature hath made the hinder-legs of the hare longer than the fore-legs; by which means she climbs the hill with much more ease than the dogs, whose legs are of equal length, and so leaves the dogs behind her, and many times escapes away clear, and saves her life. This last observation, I must confess myself to have borrowed out of the papers of my honoured friend Mr. *John Aubrey*, which he was pleased to give me a sight of.

I might here add much concerning the wiles and ruses, which these timid creatures make use of to save themselves, and escape their persecutors, but that I am somewhat diffident of the truth of those stories and relations. I shall only aver what myself have sometimes observed of a Duck, when closely pursued by a water-dog; she not only dives to save herself, (which yet she never does but when driven to an exigent, and just ready to be caught, because it is painful and difficult to her) but when she comes up again, brings not her whole body above water, but only her bill, and part of her head,

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head, holding the rest underneath, that so the dog, who the mean time turns round and looks about him, may not espy her, till she hath recovered breath.

As for *Sheep*, which have no natural weapons or means to defend or secure themselves, neither heels to run, nor claws to dig; they are delivered into the hand, and committed to the care of and tuition of man; and serving him for divers uses, are nourished and protected by him; and so enjoying their beings for a time, by this means propagate and continue their species: So that there are none destitute of some means to preserve themselves, and their kind; and these means so effectual, that notwithstanding all the endeavours and contrivances of man and beast to destroy them, there is not to this day one *Species* lost of such as are mentioned in histories, and consequently and undoubtedly neither of such as were first created.

Then for birds of prey, and rapacious animals, it is remarkable what *Aristotle* observes, That they are all solitary, and go not in flocks, *γαμψανύχων οὐδὲν ἀγελαιόν*, no birds of prey are gregarious. Again, that such creatures do not greatly multiply, *τῶν γαμψανύχων ὀλιγοτόκα πάντα*. They for the most part breeding and bringing forth but one or two, or at least a few young ones at once: Whereas they that are feeble and timorous are generally multiparous, or if they bring forth but a few at once, as *Pigeons*, they compensate that by their often breeding, *viz.* every month but two thro'out the year; by this means providing for the continuation of their kind. But for the security of these rapacious birds, it is worthy the noting, that because a prey is not always ready, but perhaps they may fail of one some days, nature hath made them patient of a long *inedia*, and be-

ides, when they light upon one, they gorge themselves so therewith, as to suffice for their nourishment for a considerable time.

*Fourthly*, I shall note the exact fitness of the parts of the bodies of animals to every one's nature and manner of living. A notable instance of which we have in the *Swine*, a creature well known, and therefore what I shall observe of it is obvious to every man. His proper and natural food being chiefly the roots of plants, he is provided with a long and strong snout; long, that he might thrust it to a sufficient depth into the ground without offence to his eyes; strong and conveniently formed for the rooting and turning up the ground. And besides, he is endued with a notable sagacity of scent, for the finding out such roots as are fit for his food. Hence in *Italy*, the usual method for finding and gathering of *Truffles*, or subterraneous mushrooms, (called by the *Italians Tartufali*, and in *Latin Tubera terræ*) is, by tying a cord to the hind-leg of a pig, and driving him before them into such pastures as usually produce that kind of mushroom, and observing where he stops and begins to root, and there digging, they are sure to find a *Truffle*; which when they have taken up, they drive away the pig to search for more. So I have myself observed, that in pastures where there are *Earth-nuts* to be found up and down in several patches, tho' the roots lie deep in the ground, and the stalks be dead long before and quite gone, the swine will by their scent easily find them out, and root only in those places where they grow.

This rooting of the Hog in the earth, calls to mind another instance of like nature, that is the *Porpeſſe*, which, as his *English* name *Porpeſſe* i. e. \* *Porc peſce*, imports, resembles  
 \* *Swine-fiſh*. the hog, both in the strength of his snout, and also in the manner of getting

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ting his food by rooting; for we found the stomach of one we dissected full of *Sand-eels*, or *Launces*, which for the most part lie deep in the sand, and cannot be gotten but by rooting or digging there. We have seen the country-people in *Cornwall*, when the tide was out, to fetch them out of the sand with iron-hooks thrust down under them, made for that purpose.

Furthermore, that very action for which the swine is abominated, and looked upon as an unclean and impure creature, namely wallowing in the mire, is designed by nature for a very good end and use, *viz.* not only to cool his body, for the fair water would have done that as well, nay, better, for commonly the mud and mire in Summer-time is warm; but also to suffocate and destroy lice, fleas, and other noisom and importunate insects, that are troublesome and noxious to him. For the same reason do all the poultry-kind, and divers other birds, bask themselves in the dust in Summer-time and hot weather, as is obvious to every one to observe.

2. A second and no less remarkable instance, I shall produce, out of Dr. *More's Antidote against Atheism*, lib. 2. cap. 10. in a poor and contemptible quadruped, the *Mole*.

First of all (saith he) her dwelling being under ground, where nothing is to be seen, nature hath so obscurely fitted her with eyes, that naturalists can scarcely agree, whether she hath any sight at all or no. [In our observation, *Moles* have perfect eyes, and holes for them through the skin, so that they are outwardly to be seen by any that shall diligently search for them; tho' indeed they are exceeding small, not much bigger than a great pin's head.] But for amends, what she is capable of for her defence and warning of danger, she has very eminently conferred upon her; for she is

very quick of hearing, [doubtless her subterraneous vaults are like trunks to convey any sound a great way.] And then her short tail and short legs, but broad fore-feet armed with sharp claws, we see by the event to what purpose they are, she so swiftly working herself under ground, and making her way so fast into the earth, as they that behold it cannot but admire it. Her legs therefore are short, that she need dig no more than will serve the mere thickness of her body: And her fore-feet are broad, that she may scoup away much earth at a time: And she has little or no tail, because she courses it not on the ground like a *Rat* or *Mouſe*, but lives under the earth, and is ſain to dig herself a dwelling there; and she making her way thro' so thick an element, which will not easily yield as the water and air do, it had been dangerous to draw so long a train behind her; for her enemy might fall upon her rear and fetch her out before she had perfected and got full possession of her works: Which being so, what more palpable argument of providence than she?

Another instance in quadrupeds might be the *Tamandua* or *Ant-bear*, described by *Marcgrave* and *Piſo*, who ſaith of them, that they are night-walkers, and seek their food by night. Being kept tame, they are fed with flesh, but it must be minced small, because they have not only a slender and sharp head and snout, but also a narrow and toothless mouth; their tongue is like a great lute-string (as big as a goose-quill) round, and in the greater kind (for there are two *Species*) more than two foot long, and therefore lies doubled in a channel between the lower parts of the cheeks. This when hungry they thrust forth, being well moistened, and lay upon the trunk of trees, and when it is covered with *Ants*, suddenly draw it back into their mouths; if the *Ants* lie so deep that they cannot

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not come at them, they dig up the earth with their long and strong claws, wherewith for that purpose their fore-feet are armed. So we see how their parts are fitted for this kind of diet, and no other; for the catching of it, and for the eating of it, it requiring no comminution by the teeth, as appears also in the *Chamælion*, which is another quadruped that imitates the *Tamandua* in this property of darting out the tongue to a great length, with wonderful celerity; and for the same purpose too of catching of insects.

Besides these quadrupeds, there are a whole genus of *Birds*, called *Pici Mercii*, or *Wood-Peckers*, that in like manner have a tongue which they can shoot forth to a very great length, ending in a sharp stiff bony rib, dented on each side; and at pleasure thrust it deep into the holes, clefts, and crannies of trees, to stab and draw out *Cossi* or any other insects lurking there, as also into *Ant-hills*, to strike and fetch out the *Ants* and their eggs. Moreover, they have short, but very strong legs, and their toes stand two forwards, two backwards, which disposition (as *Aldrovandus* well notes) nature, or rather the wisdom of the Creator, hath granted to *Wood-Peckers*, because it is very convenient for the climbing of trees, to which also conduces the stiffness of the feathers of their tails, and their bending downward, whereby they are fitted to serve as a prop for them to lean upon, and bear up their bodies. As for the *Chamælion*, he imitates the *Wood-spide*, not only in the make, motion, and use of his tongue for striking *Ants*, *Flies*, and other insects; but also in the site of his toes, whereby he is wonderfully qualified to run upon trees, which he does with that swiftness, that one would think he flew, whereas upon the ground he walks very clumsily and ridiculously. A full description of the outward and inward parts of this animal, may be



be seen at the end of *Penarolus's Observat.* It is to be noted, that the *Chamælion*, tho' he hath teeth, uses them not for chewing his prey, but swallows it immediately.

I shall add two instances more in birds, and those are,

1. The *Swallow*, whose proper food is small beteles, and other insects flying about in the air; as we have found by dissecting the stomachs both of old ones and nestlings. Which is wonderfully fitted for the catching of these animalcules; for she hath long wings, and a forked tail, and small feet, whereby she is as it were made for swift flight, and enabled to continue long upon the wing, and to turn nimbly in the air: And she hath also an extraordinary wide mouth, so that 'tis very hard for any insect, that comes in her way to escape her. It is thought to be a sign of rain, when this bird flies low near to the ground; in which there may be some truth; because the insects which she hunts may at such times, when the superior air is charged with vapours, have a sense of it, and descend near the earth. Hence, when there are no more insects in the air, as in winter-time, those birds do either abscond, or betake themselves into hot countries.

2. The *Colymbi*, or *Douchers*, or *Loons*, whose bodies are admirably fitted and conformed for diving under water, being covered with a very thick plumage, and the *Superficies* of their feathers so smooth and slippery, that the water cannot penetrate, or moisten them; whereby their bodies are defended from the cold, the water being kept at a distance, and so poised, that by a light impulse they may easily ascend in it. Then their feet are situate in the hindmost part of their body, whereby they are enabled, shooting their feet backwards, and striking the water upwards, to plunge themselves

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selves down into it with great facility, and likewise to move forwards therein. Then their legs are made flat and broad, and their feet cloven into toes with appendant membranes on each side, by which configuration they easily cut the water, and are driven forward, and so take their stroke backwards; and besides, I conceive, that by means of this figure, their feet being moved to the right and left-hand, serve them as a rudder to enable them to turn under water: For some conceive, that they swim easier under water than they do above it. How they raise themselves up again, whether their bodies emerge of themselves by their lightness, or whether by striking against the bottom, in manner of a leap, or by some peculiar motion of their legs, I cannot determine. That they dive to the bottom is clear; for that in the stomachs both of the greater and lesser kinds we found grass and other weeds, and in the lesser kind nothing else; though both prey upon fish. Their bills also are made straight and sharp for the easier cutting of the water, and striking their prey. Could we see the motions of their legs and feet in the water, then we should better comprehend how they ascend, descend, and move to and fro; and discern, how wisely and artificially their members are formed and adapted to those uses.

II. In *Birds*, all the members are most exactly fitted for the use of flying. First, The muscles, which serve to move the wings, are the greatest and strongest, because much force is required to the agitation of them; the underside of them is also made concave, and the upper convex, that they may be easily lifted up, and more strongly beat the air, which by this means doth more resist the descent of their body downwards. Then the trunk of their body doth somewhat resemble the hull of a ship;

ship; the head, the prow, which is for the most part small, that it may the more easily cut the air, and make way for their bodies; the train serves to steer, govern, and direct their flight; and however it may be held erect in their standing, or walking, yet is directed to lie almost in the same plain with their backs, or rather a little inclining when they fly. That the train serves to steer and direct their flight, and turn their bodies like the rudder of a ship, is evident in the *Kite*, who, by a light turning of his train, moves his body which way he pleases. *Idem videntur artem gubernandi docuisse caudæ flexibus, in cælo monstrante natura quod opus esset in profundo*, Plin. Lib. 10. c. 10. *They seem to have taught men the art of steering a ship by the flexures of their tails; nature shewing in the air what was needful to be done in the deep.* And 'tis notable that *Aristotle* truly observes, that whole-footed birds, and those that have long legs, have for the most part short tails; and therefore whilst they fly, do not as others, draw them up to their bellies, but stretch them at length backwards, that they may serve to steer and guide them instead of tails. Neither doth the tail serve only to direct and govern the flight, but also partly to support the body, and keep it even; wherefore, when spread, it lies parallel to the horizon, and stands not perpendicular to it, as fishes do. Hence birds that have no tails, as some sorts of *Colymbi*, or duckers, fly very inconveniently with their bodies almost erect.

To this I shall add further, that the bodies of birds are small in comparison of quadrupeds, that they may more easily be supported in the air during their flight; which is a great argument of wisdom and design: else why should not we see species of *Pegasi*, or flying-horses, of *Griffins*, of *Harpies*, and an hundred more, which might make a

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shift to live well enough, notwithstanding they could make no use of their wings: Besides, their bodies are not only small, but of a broad figure, that the air may more resist their descents; they are also hollow and light; nay, their very bones are light: For tho' those of the legs and wings are solid and firm, yet have they ample cavities, by which means they become more rigid and stiff; it being demonstrable, that a hollow body is more stiff and inflexible than a solid one of equal substance and matter. Then the feathers also are very light, yet their shafts hard and stiff, as being either empty, or filled with a light and spongy substance, and their webs are not made of continued membranes; for then, had a rupture by any accident been made in them, it could not have been consolidated, but of two series of numerous *Pumulæ*, or contiguous filaments, furnished all along with hooks on each side, whereby catching hold on one another, they stick fast together; so that when they are ruffled, or discomposed, the bird with her bill can easily preen them, and reduce them to their due position again. And for their firmer cohaesion, the wise and bountiful author of nature hath provided and placed on the rump two glandules, having their excretory vessels, round which grow feathers in form of a pencil, to which the bird turning her head, catches hold upon them with her bill, and a little compressing the glandules, squeezes out and brings away therewith an oily pap, or liniment, most fit and proper for the inunction of the feathers, and causing their filaments more strongly to cohere. And is not this strange and admirable, and argumentative of providence, that there should be such an unguent, or pap, prepared, such an open vessel to excern it into, to receive and retain it; that the bird should know where it is situate, and how, and to what purposes to use it? And because the bird is

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to live many years, and the feathers in time would, and must necessarily be worn and shattered, nature hath made provision for the casting and renewing of them yearly. Moreover, those large bladders, or membranes, extending to the bottoms of the bellies of birds, into which the breath is received, conduce much to the alleviating of the body, and facilitating of the flight: For the air received into these bladders, is by the heat of the body extended into twice, or thrice, the dimensions of the external, and so must needs add a lightness to the body. And the bird when she would descend, may either compress this air by the muscles of the *Abdomen*, or expire as much of it as may enable her to descend swifter, or slower, as she pleases. I might add the use of the feathers in cherishing and keeping the body warm; which, the creature being of small bulk, must needs stand in great stead against the rigour of the cold. And for this reason we see, that water-fowls, which were to swim, and sit long upon the cold water, have their feathers very thick set upon their breasts and bellies, and besides a plentiful down there growing, to fence against the cold of the water, and to keep off its immediate contact.

That the tails of all birds in general do not conduce to their turning to the right and left, according to the common opinion, but rather for their ascent and descent, some modern philosophers have observed and proved by experiment; for that if you pluck off, for instance, a pigeon's tail, she will nevertheless, with equal facility, turn to and fro: Which upon second thoughts, and further consideration, I grant to be true, in birds whose tails are pointed, and end in a right line: But in those that have forked tails, autopsy convinceth us that it hath this use; and therefore they pronounce too boldly of all in general. For it is manifest

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nifest to sight, that the forked-tail Kite, by turning her train sideways, elevating one horn, and depressing the other, turns her whole body. And doubtless the tail hath the same use in *Swallows*, who make the most sudden turns in the air of any birds, and have all of them forked tails.

III. As for *Fishes*, their bodies are long and slender, or else thin, for the most part, for their more easy swimming, and dividing the water. The wind-bladder, wherewith most of them are furnished, serves to poise their bodies, and keep them equiponderant to the water, which else would sink to the bottom, and lie groveling there, as hath, by breaking the bladder, been experimentally found. By the contraction and dilation of this bladder, they are able to raise, or sink themselves at pleasure, and continue in what depth of water they list. The fins, made of gristly spokes, or rays, connected, by membranes, so that they may be contracted, or extended like womens fans, and furnished with muscles for motion, serve partly for progression, but chiefly to hold the body upright; which appears in that when they are cut off, it wavers to and fro, and so soon as the fish dies, the belly turns upwards. The great strength by which fishes dart themselves forward with incredible celerity, like an arrow out of a bow, lies in their tails; their fins, meantime, lest they should retard their motion, being held close to their bodies. And therefore almost the whole musculous flesh of the body is bestowed upon the tail and back, and serves for the vibration of the tail, the heaviness and corpulency of the water requiring a great force to divide it.

In *Cetacious* fishes, or, as the *Latins* call them, \* Sea-beasts, the tail hath a different position from what it hath in

\* *Belluae  
Marinae.*



all other fishes; for whereas in these it is erected perpendicular to the Horizon, in them it lies parallel thereto, partly to supply the use of the hinder pair of fins which these creatures lack, and partly to raise and depress the body at pleasure. For it being necessary that these fishes should frequently ascend to the top of the water to breathe, or take in and let out the air, it was fitting and convenient that they should be provided with an organ to facilitate their ascent and descent as they had occasion. And as for their turning of their bodies in the water, they must perform that as birds do, by the motion of one of their fins, while the other is quiescent. It is no less remarkable in them, that their whole body is encompassed round with a copious fat, which our fishermen call the *Blubber*, of a great thickness; which serves partly to poise their bodies, and render them equiponderant to the water; partly to keep off the water at some distance from the blood, the immediate contact whereof would be apt to chill it; and partly also for the same use that clothes serve us, to keep the fish warm, by reflecting the hot steams of the body, and so redoubling the heat, as we have before-noted. For we see, by experience, that fat bodies are nothing near so sensible of the impressions of cold as lean. And I have observed fat hogs to have lain abroad in the open air, upon the cold ground, in winter nights; whereas the lean ones have been glad to creep into their cotes, and lie upon heaps to keep themselves warm.

I might here take notice of those Amphibious creatures, which we may call aquatic quadrupeds, (though one of them there is that hath but two feet, viz. the *Manati*, or Sea-cow) the *Beaver*, the *Otter*, the *Phoca*, or sea-calf, the *Water-Rat*, and the *Frog*, the toes of whose feet are joined by membranes, as in water-fowls, for swimming;

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and who have very small ears, and ear-holes, as the cetacious fishes have for hearing in the water.

To this head belongs the adapting of the parts that minister to generation in the sexes one to another; and in creatures that nourish their young with milk, the nipples of the breast to the mouth and organs of suction; which he must needs be wilfully blind and void of sense, that either discerns not, or denies to be intended and made one for the other. That the nipples should be made spungy, and with such perforations, as to admit passage to the milk when drawn, otherwise to retain it; and the teeth of the young either not sprung, or so soft and tender, as not to hurt the nipples of the dam, are effects and arguments of providence and design.

A more full description of the breasts and nipples I meet with, in a book of that ingenious anatomist and physician, *Antonius Nuck*, entitled *Adenographia Curiosa*, cap. 2. He makes the breasts to be nothing but glandules of that sort they call *Conglomeratæ*, made up of an infinite number of little knots, or kernels, each whereof has its excretory vessel, or lactiferous duct; three, or four, or five of these presently meet, and join into one small trunk, in like manner do the adjacent glandules meet and unite; several of these lesser trunks, or branches, concurring, make up an excretory vessel of a notable bigness, like to that of the *Pancreas*, but not so long, yet sufficiently large, to receive and retain a good quantity of milk; which before it enters the nipple, is again contracted, and straitned to that degree, that it will scarce admit a small bristle. Who now can be so impudent as to deny, that all this was contrived and designed purposely to retain the milk, that it should not flow out of itself, but easily be drawn out by pressure and suction; or to affirm

that this fell out accidentally, than which there could not have been a more ingenious contrivance for the use to which it is employed, invented by the wit of man?

To this head of the fitness of the parts of the body to the creatures nature, and manner of living, belongs that observation of *Aristotle*, τὴν ἐρπίθων ἕσα μὲν χαμολόνοχα σαρκοφάγα πάντα. Such birds as have crooked beaks and talons, are all carnivorous; and so of quadrupeds, καρχαρόδοντα *Carnivora omnia*. All that have ferrate teeth, are carnivorous. This observation holds true concerning all *European* birds; but I know not but that *Parrots* may be an exception to it. Yet it is remarkable, that such birds as are carnivorous have no gizzards, or musculous, but a membranous stomach, that kind of food needing no such grinding, or comminution as seeds do, but being torn into strings, or small flakes, by the beak, may be easily concocted by a membranous stomach.

To the fitness of all the parts and members of animals, to their respective uses, may also be referred another observation of the same *Aristotle*, Πάντα τὰ ζῶα ἀπ' αὐτῆς ἔχου πόδας. All animals have even feet, not more on one side than another; which, if they had, would either hinder the walking, or hang by not only useless, but also burthensome. For though a creature might make a limping shift to hop, suppose with three feet, yet nothing so conveniently or steddily to walk or run, or indeed to stand; so that we see nature hath made choice of what is most fit, proper, and useful: They have also not only an even number of feet, answering by pairs one to another, which is as well decent as convenient, but those two of an equal length, I mean, the several pairs; whereas were those on one side longer than they on the other, it would

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I shall mention but one more observation of *Aristotle*, that is, *Πτηνων μόνον ἔδν*, there is no creature only volatile, or no flying animal, but hath feet as well as wings, a power of walking or creeping upon the earth, because there is food, or at least not sufficient food for them to be had always in the air; or if in hot countries we may suppose there is, the air being never without store of insects flying about in it, yet could such birds take no rest, for having no feet they could not perch upon trees; and if they should alight upon the ground, they could by no means raise themselves any more, as we see those birds which have but short feet, as the *Swift* and *Martinet*, with difficulty do; besides, they would want means of breeding, having no where to lay their eggs, to sit, hatch, or brood their young. As for the story of the *Manucodiata*, or *Bird of Paradise*, which in the former ages was generally received and accepted for true, even by the learned, it is now discovered to be a fable, and rejected and exploded by all men, those birds being well known to have legs and feet as well as others, and those not short, small, nor feeble ones, but sufficiently great and strong, and armed with crooked talons, as being the members of birds of prey.

It is also very remarkable, that all flying insects should be covered with shelly scales, like armour, partly to secure them from external violence, from injuries by blows and pressures; partly to defend their tender muscles from the heat of the Sunbeams, which would be apt to parch and dry them up, being of small bulk; partly also to restrain the spirits, and to prevent their evaporation.

I shall now add another instance of the wisdom of nature, or rather the God of nature, in adapting

ting the parts of the same animal one to another, and that is, the proportioning the length of the neck to that of the legs. For seeing terrestrial animals, as well bird as quadrupeds, are endued with legs, upon which they stand, and wherewith they transfer themselves from place to place to gather their food, and for other conveniences of life, and so the trunk of their body must needs be elevated above the superficies of the earth, so that they could not conveniently either gather their food or drink if they wanted a neck, therefore nature hath not only furnished them therewith, but with such an one as is commensurable to their legs, except here the elephant, which hath indeed a short neck, for the excessive weight of his head and tieth, which to a long neck would have been insupportable, but is provided with a trunk, wherewith, as with a hand, he takes up his food and drink, and brings it to his mouth. I say, the necks of birds and quadrupeds are commensurate to their legs, so that they who have long legs have long necks, and they that have short legs, short ones, as is seen in the *Crocodile*, and all *Lizards*; and those that have no legs, as they do not want necks, so neither have they any, as *Fishes*. This equality between the length of the legs and neck, is especially seen in beasts that feed constantly upon grass, whose necks and legs are always very near equal; very near, I say, because the neck must necessarily have some advantage, in that it cannot hang perpendicularly down, but must incline a little; moreover, because this sort of creatures must needs hold their heads down in an inclining posture for a considerable time together, which would be very laborious and painful for the muscles, therefore on each side the ridge of the vertebres of the neck nature hath placed an *ἀκονίωμα*, or nervous ligament, of a great

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great thickness and strength, apt to stretch, and shrink again, as need requires, and void of sense, extended from the head (to which, and the next vertebres of the neck, it is fastned at that end) to the middle vetebres of the back (to which it is knit at the other) to assist them to support the head in that posture; which *Aponeurosis* is taken notice of by the vulgar by the name of *Fixfax*, or *Pack-wax*, or *White-leather*. It is also very observable in fowls that wade in the water, which having long legs, have also necks answerably long; only in these two there is an exception, exceeding worthy to be noted; for some water-fowl, which are *Palmipeds*, or whole-footed, have very long necks, and yet but short legs, as *Swans* and *Geese*, and some *Indian* birds; wherein we may observe the admirable providence of nature. For such birds as were to search and gather their food, whether herbs or insects, in the bottom of pools and deep waters, have long necks for that purpose, tho' their legs, as is most convenient for swimming, be but short; whereas there are no land-fowl to be seen with short legs and long necks, but all have their necks in length commensurate to their legs. This instance is the more considerable, because the atheists usual clam will not here help them out; for (say they) there were many animals of disproportionate parts and of absurd and uncouth shapes, produced at first, in the infancy of the world, but because they could not gather their food, or perform other functions necessary to maintain life, they soon perished, and were lost again. For these birds we see can gather their food upon land conveniently enough notwithstanding the length of their necks. For example, geese graze upon commons, and can feed themselves fat upon land; yet is there not one land bird which hath its neck thus disproportionate



nate to its legs, nor one water one neither, but such as are destined by nature in such manner as we have mentioned to search and gather their food; for nature makes not a long neck to no purpose.

*Lastly*, Another argument of providence and counsel relating to animals, is the various kinds of voices the same animal uses on divers occasions, and to different purposes. Hen-birds, for example, have a peculiar sort of voice when they would call the male; which is so eminent in *Quails*, that it is taken notice of by men, who by counterfeiting this voice with a quail-pipe, easily draw the cocks into their snares. The common hen all the while she is broody, sits and leads her chickens, uses a voice which we call *Clocking*; another she employs when she calls her chickens to partake of any food she hath found for them, upon hearing whereof they speedily run to her; another when upon sight of a bird of prey, or apprehension of any danger, she would scar them, bidding them as it were to shift for themselves, whereupon they speedily run away, and seek shelter among bushes, or in the thick grass, or elsewhere dispersing themselves far and wide. These actions do indeed necessarily infer knowledge and intention of, and direction to the ends and uses to which they serve, not in birds themselves, but in a superior agent, who hath put an instinct in them of using such a voice upon such an occasion; and in the young, of doing that upon hearing of it, which by providence was intended. Other voices she hath when angry, when she hath laid an egg, when in pain or great fear, all significant; which may more easily be accounted for, as being effects of the several passions of anger, grief, fear, joy; which yet are all argumentative of providence, in tending their several significations and uses.

I might also instance in quadrupeds, some of which

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which have as great a diversity of voices as hens themselves, and all of them significant; for example, that common domestick animal the *Cat*, as is obvious to every one to observe, and therefore I shall not spend time to mention particulars.

*Object.* But against the uses of several bodies I have instanced in that refer to man, it may be objected, that these uses were not designed by nature in the formation of the things, but that the things were by the wit of man accommodated to those uses.

To which I answer, with Dr. *More*, in the *Appendix* to his *Antidote against Atheism*, that the several useful dependencies of this kind, (*viz.* of *Stones, Timber, and Metals*, for building of houses or ships, the *Magnet* for Navigation, &c. Fire for melting of metals, and forging of instruments for the purposes mentioned) we only find, not make them. For whether we think of it or no, it is for example, manifest, that fuel is good to continue fire, and fire to melt metals, and metals to make instruments to build ships and houses, and so on. Wherefore it being true, that there is such a subordinate usefulness in the things themselves that are made to our hand, it is but reason in us to impute it to such a cause, as was aware of the usefulness and serviceableness of its own works. To which I shall add, that since we find materials so fit to serve all the necessities and conveniencies, and to exercise and employ the wit and industry of an intelligent and active Being; and since there is such an one created that is endued with skill and ability to use them, and which by their help is enabled to rule over and subdue all inferior creatures, but without them had been left necessitous, helpless, and obnoxious to injuries above any other; and since the omniscient Creator could not but know all the uses, to which they might and would

would be employed by man; to them that acknowledge the Being of a Deity, it is little less than a demonstration, that they were created intentionally, I do not say only, for those uses.

Methinks, by all this provision for the use and service of man, the Almighty interpretatively speaks to him in this manner: "I have now placed thee in a spacious and well-furnished world; I have endued thee with an ability of understanding what is beautiful and proportionable, and have made that which is so, agreeable and delightful to thee; I have provided thee with materials whereon to exercise and employ thy art and strength; I have given thee an excellent instrument, the hand, accommodated to make use of them all; I have distinguished the earth into hills and vallies, and plains, and meadows, and woods; all these parts, capable of culture and improvement by thy industry; I have committed to thee for thy assistance in thy labours of plowing, and carrying, and drawing, and travel, the laborious ox, the patient ass, and the strong and serviceable horse; I have created a multitude of seeds for thee to make choice out of them, of what is most pleasant to thy taste, and of most wholesome and plentiful nourishment; I have also made great variety of trees, bearing fruit both for food and physick, those too capable of being meliorated and improved by transplantation, stercoration, incision, pruning, watering, and other arts and devices. Till and manure thy fields, sow them with thy seeds; extirpate noxious and unprofitable herbs; guard them from the invasion and spoil of beasts; clear and fence in the meadows and pastures; dress and prune thy vines, and so rank and dispose them as is most suitable to the climate; plant thee orchards, with all sort of fruit-trees, in such order as may be most beautiful to  
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the eye, and most comprehensive of plants; gardens for culinary herbs, and all kinds of salleting; for delectable flowers, to gratify the eye with their agreeable colours and figures, and thy scent with their fragrant odours; for odoriferous and evergreen shrubs and suffrutices; for exotick and medicinal plants of all sorts; and dispose them in that comely order, as may be both pleasant to behold, and commodious for access. I have furnished thee with all materials for building, as stone, and timber, and slate, and lime, and clay, and earth, whereof to make bricks and tiles; deck and bespangle the country with houses and villages convenient for thy habitation, provided with out-houses and stables for the harbouring and shelter of thy cattle, with barns and granaries for the reception, and custody, and storing up thy corn and fruits. I have made thee a sociable creature, *ζῶν πολιτικόν*, for the improvement of thy understanding by conference, and communication of observations and experiments; for mutual help, and assistance, and defence; build thee large towns and cities with straight and well-paved streets, and elegant rows of houses, adorned with magnificent temples for my honour and worship, with beautiful palaces for thy princes and grandees, with stately halls for publick meetings of the citizens and their several companies, and the sessions of the court of judicature; besides public portico's and aqueducts. I have implanted in thy nature a desire of seeing strange and foreign, and finding out unknown countries, for the improvement, and advance of thy knowledge in *Geography*, by observing the bays, and creeks, and havens, and promontories, the out-lets of rivers, the situation of the maritime towns and cities, the longitude and latitude, &c. of those places: In *Politicks*, by noting their government, their manners,

manners, laws, and customs, their diet and medicines, their trades and manufactures, their houses and buildings, their exercises and sports, &c. In *Physiology*, or natural history, by searching out their natural rarities, the productions both of land and water; what *Species* of animals, plants, and minerals, of fruits and drugs are to be found here, what commodities for bartering and permutation, whereby thou mayest be enabled to make large additions to natural history, to advance those other sciences, and to benefit and enrich thy country by increase of its trade and merchandize. I have given thee timber and iron to build the hulls of ships, tall trees for masts, flax and hemp for sails, cables, and cordage, for rigging. I have armed thee with courage and hardiness to attempt the seas, and traverse the spacious plains of that liquid element. I have assisted thee with a compass, to direct thy course when thou shalt be out of all ken of land, and have nothing in view but sky and water. Go thither for the purposes before-mentioned, and bring home what may be useful and beneficial to thy country in general, or thyself in particular."

I persuade myself, that the bountiful and gracious Author of man's being and faculties, and all things else, delights in the beauty of his creation, and is well pleased with the industry of man, in adorning the earth with beautiful cities and castles; with pleasant villages and country houses; with regular gardens and orchards, and plantations of all sorts of shrubs, and herbs, and fruits, for meat, medicine, or moderate delight; with shady woods and groves, and walks set with rows of elegant trees; *with pastures cloathed with flocks, and valleys covered with corn*, and meadows burthened with grass, and whatever else differenceth a civil

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If a country thus planted and adorned, thus polished and civilized, thus improved to the height by all manner of culture for the support and sustenance, and convenient entertainment of innumerable multitudes of people, be not to be preferred before a barbarous and inhospitable *Scythia*, without houses, without plantations, without corn-fields or vineyards, where the roving *Hords* of the savage and truculent inhabitants transfer themselves from place to place in waggons, as they can find pasture and forage for their cattle, and live upon milk, and flesh roasted in the sun, at the pomels of their saddles; or a rude and unpolished *America*, peopled with slothful and naked *Indians*, instead of well-built houses, living in pitiful huts and cabins, made of poles set end-ways; then surely the brute beasts condition, and manner of living, to which, what we have mentioned doth nearly approach, is to be esteemed better than man's, and wit and reason was in vain bestowed on him.

Lastly, I might draw an argument of the admirable art and skill of the Creator and composer of them, from the incredible smallness of some of these natural and enlivened machines, the body of animals.

Any work of art of extraordinary fineness and subtlety, be it but a small engine or movement, or a curious carved or turned work of ivory or metals, such as those cups turned of ivory by *Oswaldus Nerlinger* of *Suevia*, mentioned by *Joan. Faber*, in his expositions of *Recchus* his *Mexican* animals, which all had the perfect form of cups, and were gilt with a golden border about the brim, of that wonderful smallness, that *Faber* himself put a thousand of them into an excavated pepper-corn; and when he was weary of the work, and yet had



not filled the vessel, his friend *John Carolus Schad*, that shewed them him, put in four hundred more. Any such work, I say, is beheld with admiration, and purchased at a great rate, and treasured up as a singular rarity in the *Musæums* and cabinets of the curious, and as such is one of the first things shewed to *Travellers* and *Strangers*. But what are these for the fineness and parvity (for which alone, and their figure, they are considerable) to those minute machines endued with life and motion, I mean, the bodies of those *Animalcula*, not long since discovered in *Pepper-water*, by Mr. *Leuenhoek*, of *Delft* in *Holland*, (whose observations were confirmed and improved by our learned and worthy countryman, Dr. *Robert Hook*) who tells us, that some of his friends (whose testimonials he desired,) did affirm, that they had seen 10000, others 30000, others 45000 little living creatures, in a quantity of water no bigger than a grain of millet; and yet he made it his request to him, that they would only justify (that they might be within compass) half the number that they believed each of them saw in the water. From the greatest of these numbers he infers, that there will be 8280000 of these living creatures seen in one drop of water; which number (saith he) I can with truth affirm, I have discerned. This (proceeds he) doth exceed belief: But I do affirm, if a large grain of sand were broken into 8000000 of equal parts, one of these would not exceed the bigness of one of those creatures. Dr. *Hook* tells us, That after he had discovered vast multitudes of those exceeding small creatures which Mr. *Leunhoek* had described, upon making use of other lights and glasses, he not only magnified those he had discovered to a very great bigness, but discovered many other sorts very much smaller than them he first saw, and some of them

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Part I. them so exceeding small, that millions of millions might be contained in one drop of water. If *Pliny* considering such insects as were known to him, and those were none but what were visible to the naked eye, was moved to cry out, That the artifice of nature was no where more conspicuous than in these: And again, *In his tam parvis atque tam nullis quæ ratio, quanta vis, quam inextricabilis, perfectio?* And again, *Rerum natura nusquam, magis quam in minimis tota est*, Hist. Nat. l. 11. c. 1. What would he have said, if he had seen animals of so stupendous smallness, as I have mentioned? How would he have been rapt into an extasie of astonishment and admiration?

Again: If considering the body of a gnat, (which by his own confession is none of the least of insects) he could make so many admiring queries, *Where hath nature disposed so many senses in a gnat? Ubi visum prætendit; Ubi gustatum applicavit? Ubi odoratum inseruit? Ubi vero truculentam illam & portione maximam vocem ingeneravit? Qua subtilitate pennas adnexuit? Prælongavit pedum crura? Disposuit jejunam caveum uti alvum? Avidam sanguinis & potissimum humani sitim accendit? Telum vero perfodiendo tergori quo spiculavit ingenio? Atque ut in capaci, cum cerni non possit exilitas, ita reciproca geminavit arte, ut fodiendo acuminatum pariter sorbendoque fistulosum esset.* Which words should I translate, would lose their emphasis and elegancy; if, I say, he could make such queries about the members of a gnat, what may we make, and what would he in all likelihood have made, had he seen these incredibly small living creatures? How would he have admired the immense stability (as he phrases it) of their parts? For to use *Dr. Hook's* words in his *Microscopium*, p. 103. If these creatures be so exceeding small, what must we think of their muscles and other parts? Certain

it is, that the mechanism by which nature performs the muscular motion, is exceeding small and curious, and to the performance of every muscular motion, in greater animals at least, there are not fewer distinct parts concerned than many millions of millions, and these visible thro' a Microscope.

*Use.* Let us then consider the works of God, and observe the operations of his hands: Let us take notice of, and admire his infinite wisdom and goodness in the formation of them: No creature in this sublunary world is capable of so doing, besides man, and yet we are deficient herein: We content ourselves with the knowledge of the tongues, or a little skill in philology, or history perhaps, and antiquity, and neglect that which to me seems more material, I mean, natural history, and the works of the creation: I do not discommend or derogate from those other studies: I should betray mine own ignorance and weakness, should I do so; I only wish they might not altogether jumble out, and exclude this. I wish that this might be brought in fashion among us: I wish men would be so equal and civil, as not to disparage, deride, and vilifie those studies which themselves skill not of, or are not conversant in; no knowledge can be more pleasant than this, none that doth so satisfy and feed the soul; in comparison whereto that of words and phrases seem to me insipid and jejune. That learning (saith a wise and observant Prelate) which consists only in the form and pedagogy of arts, or to the critical notions upon words and phrases, hath in it this intrinsical imperfection, that it is only so far to be esteemed, as it conduceth to the knowledge of things, being in itself but a kind of pedantry, apt to infect a man with such odd humours of pride, and affectation, and curiosity, as will render him unfit for any great employment. Words being but the images and matter, to be wholly

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wholly given up to the study of these, what is it but *Pygmalion's* frenzy, to fall in love with a picture or image? As for *Oratory*, which is the best skill about words, that hath by some wise men been esteemed, but a voluntary art, like to cookery, which spoils wholesome meats, and helps unwholesome, by the variety of sauces, serving more to the pleasure of taste, than the health of the body.

It might be (for ought I know, and as some divines have thought) part of our business and employment in eternity, to contemplate the works of God, and to give him the glory of his wisdom, power, and goodness, manifested in the creation of them. I am sure it is part of the business of a sabbath-day, and the sabbath is a type of that eternal rest; for the sabbath seems to have been first instituted for a commemoration of the works of the creation, from which God is said to have rested upon the Sabbath-day.

It is not likely that eternal life shall be a torpid and unactive state, or that it shall consist only in an uninterrupted and endless act of love; the other faculties shall be employed as well as the will in actions suitable to and perfective of their natures; especially the understanding, the supreme faculty of the soul, which chiefly differenceth us from brute beasts, and makes us capable of virtue and vice, of rewards and punishments, shall be busied and employed in contemplating the works of God, and observing the divine art and wisdom, manifested in the structure and composition of them, and reflecting upon their great architect the praise and glory due to him; then shall we clearly see, to our great satisfaction and admiration, the ends and uses of these things, which here were either too subtil for us to penetrate and discover, or too remote and unaccessible for us to come to any dis-

distinct view of, viz. the planets and fixed stars, those illustrious bodies, whose contents and inhabitants, whose stores and furniture, we have here so longing a desire to know, as also their mutual subserviency to each other. Now the mind of man being not capable at once to advert to more than one thing, a particular view and examination of such an innumerable number of vast bodies, and the great multitude of *Species*, both of animate and inanimate Beings, which each of them contains, will afford matter enough to exercise and employ our minds, I do not say to all eternity, but to many ages, should we do nothing else.

Let it not suffice us to be book-learned, to read what others have written, and to take upon trust more falshood than truth; but let us ourselves examine things as we have opportunity, and converse with nature as well as books. Let us endeavour to promote and increase this knowledge, and make new discoveries, not so much distrusting our own parts, or despairing of our own abilities, as to think that our industry can add nothing to the invention of our ancestors, or correct any of their mistakes. Let us not think that the bounds of science are fixed, like *Hercules's* pillars, and inscribed with a *Ne plus ultra*; let us not think we have done when we have learned what they have delivered to us; the treasures of nature are inexhaustible; here is employment enough for the vastest parts, the most indefatigable industries, the happiest opportunities, the most prolix and undisturbed vacancies. *Multa venientis ævi populus ignota nobis sciet: Multa sæculis tunc futuris, cum memoria nostri exoleverit reservantur. Pusilla res mundus est, nisi in eo quod quærat omnis mundus habeat.* Seneca Nat. Quaest. Lib. 7. Cap. 31. The people of the next age shall know many things unknown to us: Many are reserved for ages then to

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come, when we shall be quite forgotten, no memory of us remaining. The world would be a painful small thing indeed, if it did not contain enough for the enquiries of the whole world. Yet, and again, Epist. 64. *Multum adhuc restat operis, multumque restabit, nec ulli nato post mille sæcula præcludetur occasio aliquid adhuc adjiciendi.* Much work still remains, and much will remain; neither to him that shall be born after a thousand ages, will matter be wanting for new additions to what hath already been invented. Much might be done would we but endeavour, and nothing is insuperable to pains and patience. I know that a new study at first seems very vast, intricate, and difficult; but after a little resolution and progress, after a man becomes a little acquainted, as I may so say, with it, his understanding is wonderfully cleared up and enlarged, the difficulties vanish, and the thing grows easy and familiar. And for our encouragement in this study, observe what the Psalmist saith, Psalm cxi. 2. *The works of the Lord are great, sought out of all them that have pleasure therein.* Which tho' it be principally spoken of the works of providence, yet may as well be verified of the works of the creation. I am sorry to see so little account made of real experimental philosophy in this \* University, and that those ingenious sciences of the Mathematicks are so much neglected by us; and therefore do earnestly exhort those that are young, especially gentlemen, to set upon these studies; they may possibly invent something of eminent use and advantage to the world; and one such discovery would abundantly compensate the expence and travel of one man's whole life. However, it is enough to maintain and continue what is already invented; neither do I see what more ingenious and manly employment

they

\* Cambridge, where the Author lived at the first writing of this.



they can pursue, tending more to the satisfaction of their own minds, and the illustration of the glory of God, for he is wonderful in all his works.

But I would not have any man cross his natural genius or inclinations, or undertake such methods of study as his parts are not fitted to, or not serve those ends to which his friends, upon mature deliberation, have designed him; but those who do abound with leisure, or who have a natural propension, and genius inclining them thereto; or those who by reason of the strength and greatness of their parts, are able to compass and comprehend the whole latitude of learning.

Neither yet need those who are designed to divinity itself fear to look into these studies, or think they will engross their whole time, and that no considerable progress can be made therein, unless men lay aside and neglect their ordinary callings and necessary employments. No such matter. Our life is long enough, and we might find time enough did we husband it well: *Vitam non accepimus brevem, sed fecimus, nec inopes ejus, sed prodigi sumus*, as *Seneca* saith, *We have not received a short life but have made it so; neither do we want time, but are prodigal of it.* And did but young men fill up that time with these studies, which lies upon their hands, which they are incumbered with, and troubled how to pass away, much might be done even so. I do not see but the study of true physiology may be justly accounted a proper or Προπαιδεια preparative to divinity. But to leave that, it is a generally received opinion, that all this visible world was created for man; that man is the end of the creation; as if there were no other end of any creature, but some way or other to be serviceable to man. This opinion is as old as *Tully*; for saith he, in his second book, *De Nat. Deorum. Principio ipse mundus deorum homi-*

*minumque causa factus est: Quæque in eo sunt omnia ea parata ad fructum hominum & inventa sunt.*

But tho' this be vulgarly received, yet wise men now-a-days think otherwise. Dr. More

affirms, \* *That creatures are made to enjoy themselves as well as to serve us; and that it is a gross piece of ignorance*

\* Antidote  
Atheism, L.  
2. c. 11.

*and rusticity to think otherwise.* And in another place: *This comes only out of pride and ignorance or a haughty presumption; because we are encouraged to believe that in some sense all things are made for man, therefore to think that they are not at all made for themselves. But he that pronounceth this, is ignorant of the nature of man, and the knowledge of things: For if a good man be merciful to his beast, then surely a good God is bountiful and benign, and takes pleasure that all his creatures, should enjoy themselves, that have life and sense, and are capable of enjoyment.*

Those philosophers indeed who hold man to be the only creature in this sublunary world endued with sense and perception and that all other animals are mere machines or puppets, have some reason to think that all things here below were made for man. But this opinion seems to me too mean, and unworthy the Majesty, Wisdom, and Power of God; nor can it well consist with his veracity, instead of a multitude of noble creatures, endued with life and sense, and spontaneous motion, as all mankind till of late years believed, and none ever doubted of (so that it seems we are naturally made to think so) to have stocked the earth with divers sets of *Automata*, without all sense and perception, being wholly acted from without, by the impulse of external objects.

But be this so, there are infinite other creatures without the earth, which no considerate man can think were made only for man, and have no other

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use. For my part, I cannot believe that all things in the world were so made for man, that they have no other use.

For it seems to me highly absurd and unreasonable, to think that bodies of such vast magnitude as the fixed stars, were only made to twinkle to us, nay, a multitude of them there are, that do not so much as twinkle, being either by reason of their distance, or of their smallness, altogether invisible to the naked eye, and only discoverable by a telescope; and it is likely, perfecter telescopes than we yet have, may bring to light many more; and who knows, how many lie out of the ken of the best telescope that can possibly be made? And, I believe, there are many species in nature, even in this sublunary world, which were never yet taken notice of by man, and consequently of no use to him, which yet we are not to think were created in vain; but may be found out by, and of use to, those who shall live after us in future ages. But though in this sense it be not true, that all things were made for man; yet, thus far it is that all the creatures in the world may be some way or other useful to us, at least to exercise our wits and understandings, in considering and contemplating of them, and so afford us subject of admiring and glorifying their and our maker. Seeing then, we do believe, and assert, that all things were in some sense made for us, we are thereby obliged to make use of them for those purposes for which they serve us, else we frustrate this end of their creation. Now some of them serve only to exercise our minds: Many others there be, which might probably serve us to good purpose, whose uses are not discovered, nor are they ever like to be, without pains and industry. True it is, many of the greatest inventions have been accidentally stumbled upon; but

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not by men supine and careless, but busy and inquisitive. Some reproach methinks it is to learned men, that there should be so many animals in the world, whose outward shape is not yet taken notice of, or described, much less their way of generation, food, manners, uses, observed.

The Scripture, *Psalms cxlviii.* calls upon *the sun, moon, and stars, fire and hail, snow, and vapour, stormy winds and tempests, mountains and all hills, fruitful trees, and all cedars, beasts and all cattle, creeping things and flying fowl, &c. to praise the Lord.* How can that be? Can senseless and inanimate things praise God? Such as are the sun, and moon, and stars. And although beasts be advanced higher to some degree of sense and perception: yet being void of reason and understanding, they know nothing of the causes of things, or of the author and maker of themselves, and other creatures. All that they are capable of doing, in reference to the praising of God, is (as I said before) by affording matter, or subject, of praising him, to rational and intelligent Beings. So the Psalmist, *Psalms xix. 1.* *The heavens declare the glory of God, and the firmament sheweth his handy work.* And therefore the Psalmist, when he calls upon sun, and moon, and stars, to praise God, doth in effect call upon men and angels, and other rational beings, to consider those great effects of the divine power and wisdom, their vast dimensions, their regular motions and periods, their admirable disposition and order, their eminent ends and uses in illuminating and enlivening the planets, and other bodies about them, and their inhabitants, by their comfortable and cherishing light, heat, and influences, and to give God the glory of his power, in making such great and illustrious bodies, and of his wisdom and goodness

ness in so placing and disposing of them, so moving them regularly and constantly, without clashing or interfering, one with another, and enduing them with such excellent virtues and properties, as to render them so serviceable and beneficial to man, and all other creatures about them.

The like may be said of fire, hail, snow, and other elements and meteors, of trees, and other vegetables, of beasts, birds, insects, and all animals, when they are commanded to praise God, which they cannot do by themselves; man is commanded to consider them particularly, to observe and take notice of their curious structure, ends, and uses, and give God the praise of his wisdom, and other attributes therein manifested.

And therefore those who have leisure, opportunity, and abilities, to contemplate and consider any of these creatures, if they do it not, do as it were rob God of some part of his glory, in neglecting or slighting so eminent a subject of it, and wherein they might have discovered so much art, wisdom, and contrivance.

And it is particularly remarkable, that the divine author of this *Psalms*, amongst other creatures, calls upon insects also to praise God; which is as much as to say, Ye sons of men, neglect none of his works, those which seem most vile and contemptible: There is praise belongs to him for them. Think not that any thing he hath vouchsafed to create, is unworthy thy cognizance, to be slighted by thee. It is pride and arrogance, or ignorance and folly, in thee so to think. There is a greater depth of art and skill in the structure of the meanest insect, than thou art able for to fathom, or comprehend.

The wisdom, art, and power of Almighty God, shines forth as visibly in the structure of the body of the minutest insect, as in that of a horse,  
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or Elephant: Therefore God is said to be, *Maximus in minimis*. We men esteem it a most difficult matter, and of greater art and curiosity, to frame a small watch, than a large clock: And no man blames him who spent his whole time in the consideration of the nature and works of a bee, or thinks his subject was too narrow. Let us not then esteem any thing contemptible, or inconsiderable, or below our notice taking; for this is to derogate from the wisdom and art of the Creator, and to confess ourselves unworthy of those endowments of knowledge and understanding which he hath bestowed on us. Do we praise *Dædalus* and *Architas*, and *Hero*, and *Callicrates*, and *Albertus Magnus*, and many others which I might mention, for their cunning in inventing, and dexterity in framing and composing a few dead engines, or movements, and shall we not admire and magnify the great *Δημιουργὸς Κόσμου*, *Former of the world*, who hath made so many, yea, I may say, innumerable, rare pieces, and those two not dead ones, such as cease presently to move so soon as the spring is down; but all living, and themselves performing their own motions, and those so intricate and various, and requiring such a multitude of parts and subordinate machines, that it is incomprehensible what art and skill, and industry, must be employed in the framing of one of them?

I have already noted out of Dr. *Hook*, that to the performance of every muscular motion, at least in greater animals, there are not fewer distinct parts concerned, than many millions of millions.

Further, from the consideration of our own smallness and inconsiderableness, in respect of the greatness and splendor of those glorious heavenly bodies, the sun, moon, and stars, to which our bodies bear no proportion at all either in magnitude,



rude, or lustre; let us with the holy *Psalmist* raise up our hearts to magnify the goodness of God towards us in taking such notice of us, and making such provision for us, and advancing us so highly above all his works, *Psalm viii. 3. When I consider the heavens, the work of thy fingers, the moon and the stars which thou hast ordained: What is man that thou art mindful of him, and the son of man that thou visitest him? For thou hast made him a little lower than the angels, and hast crowned him with glory and honour, &c.*

But it may be objected, that God Almighty was not so selfish and desirous of glory, as to make the world and all the creatures therein, only for his own honour, and to be praised by man. To assert this, were, in *Des Cartes's* opinion, an absurd and childish thing, and a resembling of God to a proud man. It is more worthy the Deity, to attribute the creation of the world, to the exundation and overflowing of his transcendent and infinite goodness, which is of its own nature, and in the very notion of it, most free, diffusive, and communicative.

To this I shall answer in two words; First, The testimony of Scripture makes God in all his actions to intend and design his own glory mainly, *Prov. xvi. 4. God made all things for himself.* How! for himself? He hath no need of them; He hath no use of them. No, he made them for the manifestation of his power, wisdom, and goodness, and that he might receive from the creatures, that were able to take notice thereof, his tribute of praise, *Psalm l. 15. Offer unto God thanksgiving.* And in the next verse, *I will deliver thee, and thou shalt glorify me.* And again in the last verse, *Whoso offereth praise, glorifieth me.* So praise is called a sacrifice, and *the calves of the lips.* *Hof. xiv. 2. Isa. xlii. 8. I am the Lord, that is my*

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*my name, and my glory will I not give to another, Iſa. xlviii. 11. And I will not give my glory to another.* The ſcripture calls upon the heavens, the earth, and ſun, and moon, and ſtars, and all other creatures, to praiſe the Lord; that is, by the mouth of man, (as I ſhewed before) who is hereby required to take notice of all theſe creatures, and to admire and praiſe the power, wiſdom, and goodneſs of God, manifeſted in the creation and deſignations of them.

Secondly, It is moſt reaſonable that God Almighty ſhould intend his own glory: For he being infinite in all excellencies and perfections, and independent upon any other being; nothing can be ſaid or thought of him too great, and which he may not juſtly challenge as his due; nay, he cannot think too highly of himſelf, his other attributes being adequate to his underſtanding; ſo that, though his underſtanding be infinite, yet he underſtands no more than his power can effect, becauſe that is infinite alſo. And therefore it is fit and reaſonable, that he ſhould own and accept the creatures acknowledgments and celebrations of thoſe virtues and perfections, which he hath not received of any other, but poſſeſſeth eternally and originally of himſelf. And indeed, (with reverence be it ſpoken) what elſe can we imagine the ever bleſſed Deity to delight and take complacency in for ever, but his own infinite excellencies and perfections, and the manifeſtations and effects of them, the works of the creation, and the ſacrifices of praiſe and thanks offered up by ſuch of his creatures as are capable of conſidering thoſe works, and diſcerning the traces and footſteps of his power and wiſdom appearing in the formation of them; and moreover, whoſe bounden duty it is ſo to do? The reaſon why man ought not to admire himſelf, or ſeek his own glory, is, becauſe he is a

dependent creature, and hath nothing but what he hath received; and not only dependent, but imperfect; yea, weak and impotent: And yet I do not take humility in man to consist in disowning, or denying any gift or ability that is in him, but in a just valuation of such gifts and endowments, yet rather thinking too meanly than too highly of them; because human nature is so apt to err in running into the other extreme, to flatter itself, and to accept those praises that are not due to it; pride being an elation of spirit upon false grounds, or a desire and acceptance of undue honour. Otherwise, I do not see why a man may not admit, and accept the testimonies of others, concerning any perfection, accomplishment, or skill, that he is really possessed of, yet can he not think of himself to deserve any praise or honour for it, because both the power and the habit are the gift of God: And considering that one virtue is counter-balanced by many vices, and one skill or perfection with much ignorance and infirmity.

*The End of the First Part.*

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THE  
WISDOM OF GOD  
Manifested in the  
WORKS  
OF THE  
CREATION.

Particularly in the

- I. Whole Body of the EARTH.
- II. Bodies of MAN,  
And other ANIMALS.

PART II.

I Proceed now to select some particular pieces of the creation, and to consider them more distinctly. They shall be only two.

- I. The whole Body of the Earth.
- II. The Body of Man.

*First*, The Body of the Earth; and therein I shall take notice of, 1. Its Figure. 2. Its Motion. 3. The constitution of its parts.

By earth I here understand not the dry land, or the earth contradistinguished to water, or the earth considered as an element, but the whole *Terrestrial* Globe composed of earth and water.

1. For the *Figure*, I could easily demonstrate it to be spherical. That the water, which by reason of its fluidity should, one would think, compose itself to a level, yet doth not so, but hath a gibbous *Superficies*, may to the eye be demonstrated upon the sea. For when two ships sailing contrary ways lose the sight one of another, first the keel and hull disappear, afterwards the sails; and if when upon the deck you have perfectly lost sight of all, you get up to the top of the main-mast, you may descry it again. Now what should take away the sight of these ships from each other but the gibbosity of the interjacent water? The roundness of the earth from north to south is demonstrated from the appearance of northern stars above the Horizon, and loss of the southern to them that travel northward; and on the contrary, the loss of the northern, and appearance of the southern to them that travel southward. For were the earth a plain, we should see exactly the same stars wherever we were placed on that plain. The roundness from east to west is demonstrated from *Eclipses* of either of the great *Luminaries*. For why the same *Eclipse*, suppose of the *Sun*, which is seen to them that live more easterly, when the sun is elevated six degrees above the Horizon, should be seen to them that live one degree more westerly, when the sun is but five degrees above the Horizon, and so lower and lower proportionably to them that live more and more westerly, till at last it appear not at all, no account can be given but the globosity of the earth. For were the earth a perfect plain, the sun would appear eclipsed to all that live upon that plain, if not exactly in the same elevation, yet

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pretty near it; but to be sure it would never appear to some, the sun being elevated high above the Horizon; and not at all to others. It being clear then that the figure of the earth is spherical, let us consider the conveniences of this figure.

1. No figure is so capacious as this, and consequently whose parts are so well compacted and united, and lie so near one to another for mutual strength. Now the earth, which is the basis of all animals, and; as some think, of the whole creation, ought to be firm, and stable, and solid, and as much as is possible secured from all ruins and concussions.

2. This figure is most consonant and agreeable to the natural *Nutus*, or tendency of all heavy bodies. Now the earth being such a one, and all its parts having an equal propension or connivency to the centre, they must needs be in greatest rest, and most immoveable, when they are all equidistant from it; whereas were it an angular body, all the angles would be vast and steep mountains, bearing a considerable proportion to the whole bulk, and therefore those parts being extremely more remote from the centre than those about the middle of the plains, would consequently press very strongly thitherward, and unless the earth were made of adamant, or marble, in time the other parts would give way till all were levelled.

3. Were the earth an angular body, and not round, all the whole earth would be nothing else but vast mountains, and so incommodious for animals to live upon, for the middle point on every side would be nearer the centre than any other, and consequently from that point, which way soever one travelled, would be up-hill, the tendency of all heavy bodies being perpendicularly to the centre; besides, how much this would obstruct commerce, is easily seen; for not only the declivity of all places would render them very difficult to be travelled over,



over, but likewise the midst of every side being lowest and nearest the centre, if there were any rain, or any rivers, must needs be filled with a lake of water, there being no way to discharge it, and possibly the water would rise so high as to overflow the whole *Latus*. But, surely, there would be much more danger of the inundation of whole countries than now there is, all the waters falling upon the earth, by reason of its declivity every way, easily descending down to the common receptacle of the sea. And these lakes of water being far distant one from another, there could be no commerce between far remote countries, but by land.

4. A spherical figure is most commodious for *Dinetal* motion, or revolution, upon its own *Axis*; for in that, neither can the medium at all resist the motion of the body, because it stands not in its way, no part coming into any space but what the precedent left, neither doth one part of the superficies move faster than another: whereas were it angular, the parts about the angles would find strong resistance from the air, and those parts also about the angles would move much faster than those about the middle of the planes, being remoter from the centre than they. It remains therefore that this figure is the most commodious for motion.

Here I cannot but take notice of the folly and stupidity of the *Epicureans*, who fancied the earth to be flat and contiguous to the heavens on all sides, that it descended a great way with long roots; and that the sun was new made every morning, and not much bigger than it seems to the eye, and of a flat figure, and many other such gross absurdities as children amongst us would be ashamed of.

*Secondly*, I come now to speak of the *Motion* of the *Earth*. That the *Earth* (speaking according to philosophical accurateness) doth move both upon  
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its own poles and in the *Ecliptick*, is now the received opinion of the most learned and skilful *Mathematicians*. To prove the diurnal motion of it upon its poles, I need produce no other argument than, *First*, The vast disproportion in respect of magnitude, that is between the earth and the heavens, and the great unlikelihood that such an infinite number of vast bodies should move about so inconsiderable a spot as the earth, which in comparison with them, by the concurrent suffrages of mathematicians, of both persuasions, is a mere point, that is, next to nothing. *Secondly*, The immense and incredible celerity of the motion of the heavenly bodies in the ancient *Hypothesis*. *Thirdly*, Of its annual motion in the *Ecliptick*, the stations and retrogradations of the superior planets are a convincing argument, there being a clear and facile account thereof to be given from the mere motion of the earth in the *Ecliptick*; whereas in the old *Hypothesis* no account can be given, but by the unreasonable fiction of *Epicycles*, and contrary motions; add hereto, the great unlikelihood of such an enormous *Epicycle* as *Venus* must describe about the sun, not under the sun, as the old astronomers fancied. About the sun, I say, as appears by its being hid or eclipsed by it, and by its several *Phases*, like the *Moon*. So that whosoever doth clearly understand both *Hypotheses*, cannot, I persuade myself, adhere to the old, and reject the new, without doing some violence to his faculties.

Against this opinion lie two objections, *First*, That it is contrary to sense, and the common opinion and belief of mankind. *Secondly*, That it seemeth contrary to some expressions in *Scripture*. To the first I answer, That our senses are sometimes mistaken, and what appears to them is not always in reality so as it appears. For example: The sun, or moon, appear no bigger, at most, than

than a cart-wheel, and of a flat figure. The earth seems to be plain: The heavens to cover it like a canopy, and to be contiguous to it round about: A fire-brand nimbly moved round, appears like a circle of fire; and to give a parallel instance, a boat lying still at anchor in a river, to him that sails and rows by it, seems to move apace; and when the clouds pass nimbly under the moon, the moon itself seems to move the contrary way. And there hath been whole books written in confutation of vulgar errors. *Secondly*, As to the *Scripture*, when speaking of these things, it accommodates itself to the common and received opinions, and employs the usual phrases and forms of speech (as all wise men also do, though, in strictness, they be of a different or contrary opinion) without intention of delivering any thing doctrinally concerning these points, or confuting the contrary: And yet by those that maintain the opinion of the earth's motion, there might a convenient interpretation be given of such places as seem to contradict it. Howbeit, because some pious persons may be offended at such an opinion, as favouring of novelty, thinking it inconsistent with divine revelation, I shall not positively assert it, only propose it as an *Hypothesis* not altogether improbable. Supposing then, that the earth doth move about upon its own poles, and in the ecliptic about the sun, I shall shew how admirably its situation and motion are contrived for the conveniency of man, and other animals: Which I cannot do more fully and clearly than Dr. *More* hath already done in his *Antidote against Atheism*, whose words therefore I shall borrow.

First, Speaking of the *Parallelism* of the *Axis* of the *Earth*, he saith, I demand whether it be better to have the *Axis* of the earth steady, and perpetually parallel to itself, or to have it carelessly tumble

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ble this way and that way as it happens, or at least very variously and intricately? And you cannot but answer me, it is better to have it steady and parallel; for in this lies the necessary foundation of the art of navigation and dialling. For that steady stream of particles, which is supposed to keep the *Axis* of the *Earth* parallel to itself, affords the mariner both his *Cynosura*, and his *Compass*. The *Load-stone* and the *Load-star* depend both upon this. The *Load-stone*, as I could demonstrate, were it not too great a digression; and the *Load-star*, because that which keeps the *Axis* parallel to itself, makes each of the *Poles* constantly respect such a point in the heavens, as for example, the *North-pole* to point almost directly to that which we call the *Pole-star*. And besides, *Dialling* could not be at all without this steadiness of the *Axis*. But both these arts are pleasant, and one especially of mighty importance to mankind. For thus there is an orderly measuring of our time for affairs at home, and an opportunity of traffick abroad, with the most remote nations of the world, and so there is a mutual supply of the several commodities of all countries, besides the enlarging our understandings by so ample experience we get both of men and things. Wherefore if we were rationally to consult, whether the *Axis* of the *Earth* were better beheld steady and parallel to itself, or left at random, we would conclude it ought to be steady, and so we find it *de Facto*, tho' the earth move floating in the liquid *Heavens*. So that appealing to our own faculties we are to affirm, That the constant direction of the *Axis* of the *Earth*, was established by a principle of wisdom and council.

Again, There being several postures of this steady direction of the *Axis* of the *Earth*, viz. either perpendicular to a plane, going thro' the centre of the *Sun*, or co-incident, or inclining, I demand which

which of all these reason and knowledge would make choice of? Not of a perpendicular posture; for so both the pleasant variety, and great convenience of Summer and Winter, Spring and Autumn, would be lost, and for want of accession of the sun, these parts of the earth, which now bring forth fruits, and are habitable, would be in an incapacity of ever bringing forth any; sith then, the heat could never be greater than now it is at our 10th of *March*, or the 11th of *September*, and therefore not sufficient to bring their fruits and grain to maturity, and consequently could entertain no inhabitants; and those parts that the full heat of the sun could reach, by plying them always alike without any annual recession, or intermission, would at last grow tired, or exhausted, or be wholly dried up, and want moisture, the sun dissipating and casting off the clouds northwards and southwards. Besides, we observe that an orderly vicissitude of things, doth much more gratify the contemplative property in man.

And now in the second place, neither would reason make choice of a co-incident position. For if *Axis* thus lay in a plane that goeth through the centre of the *Sun*, the *Ecliptick* would, like a *Colure*, or one of the *Meridians*, pass thro' the *Poles* of the earth, which would put the inhabitants of the world into a pitiful condition. For they that escape best in the *Temperate Zone*, would be accloyed with long nights very tedious, no less than forty days, and those that now never have their night above twenty-four hours, as *Friesland*, *Iceland*, the further parts of *Russia* and *Norway*, would be deprived of the sun, above an hundred and thirty days together. Ourselves in *England*, and the rest of the same clime, would be closed up in darkness no less than a hundred, or eighty days; and so proportionably of the rest, both in  
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and out of the *Temperate Zone*. And as for Summer and Winter, though those vicissitudes would be, yet it could not but cause raging diseases, to have the sun stay so long, describing his little circles so near the poles, and lying so hot on the inhabitants, that had been in so long extremity of darkness and cold before.

It remains therefore, that the posture of the *Axis* of the earth be inclining, not perpendicular, not co-incident to the fore-mentioned plane. And verily, it is not only inclining, but in so fit a proportion, and there can be no fitter imagined to make it, to the utmost capacity, as well pleasant as habitable. For though the course of the sun be curbed between the Tropicks, yet are not those parts directly subject to his perpendicular beams, either uninhabitable, or extremely hot, as the ancients fancied: By the testimony of travellers, and particularly Sir *Walter Raleigh*, the parts under and near the line, being as fruitful and pleasant, and fit to make a paradise of, as any in the world. And that they are as suitable to the nature of man, and as convenient to live in, appears from the longaeivity of the natives; as for instance, the *Æthiopes*, called by the ancients *Μαυροί*; but especially in the *Brasilians* in *America*, the ordinary term of whose life is a hundred years, as is set down by *Piso*, a learned physician of *Holland*, who travelled thither on purpose to augment natural knowledge, but especially what related to physick. And reasonable it is that this should be so; for neither doth the sun lie long upon them, their day being but twelve hours, and their night as long, to cool and refresh them: And besides, they have frequent showers, and constant breezes, or fresh gales of wind from the *East*. It was the opinion of *Asclepides*, as *Plutarch* reports, that generally the inhabitants of

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cold countries are longer-lived than those of hot, because the cold keeps in the natural heat, as it were locking up the pores to prevent its evaporation; whereas in hot regions the heat is easily dissipated, the pores being large and open to give it way. Which opinion, because I find some learned men still adhere to, I shall produce some further instances out of Monsieur *Rocheforts's* history of the *Antilles* islands, to confirm the contrary, and to shew how often and easily we may be deceived, if we trust to our own ratiocinations, how plausible soever, and consult not experience.

The ordinary life (saith he) of our *Caribbeans* is an hundred and fifty years long, and sometimes more. There were some among them not long since living, who remembred to have seen the first *Spaniards* that boarded *America*, who we may thence conclude, lived to be at least 160 years old.

The *Hollanders* who traffick in the *Molucca* islands, assure us, that the ordinary term of life of the natives there is one hundred and thirty years.

*Vincent le Blanc* tells us, that in *Sumatra Java*, and the neighbouring islands, the life of the inhabitants is extended to 140 years, and that in the realm of *Cassuby* it reaches 150. *Francis Pirara* promotes the life of the *Brasilians* beyond the term we have set it, v.g. to 160 years or more, and says that in *Florida* and *Jucatan* there are men found who pass that age. And it is said, that the *French* in *Laudonior's* voyage into *Florida*, Anno 1564. saw a certain old man, who affirmed himself to be three hundred years old, and the father of five generations; And well he might be of double that number.

Lastly, *Mapheous* reports, that a certain *Bengalife* vaunted himself to be 335 years old. So far Monsieur *Rochefort*. Indeed these two last instances, being perchance singular and extraordinary,

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do not prove the point; for even among us, where the ordinary term of life is about threescore and ten, or fourscore, there occur some rare instances of persons, who have lived 130, 140, 150 years and more. But the other testimonies being general, prove it beyond contradiction; neither yet is the thing in itself improbable; for there being not so great inequality of weather in those hot countries, as there is in cold, the body is kept in a more equal temper, and not having such frequent shocks, as are occasioned by such air, and often changes, and that from one extreme to another, holds out much longer. So we see infirm and crazy persons, when they come to be so weak as to be fixed to their beds, hold out many years, some I have heard of, that have lain bed-ridden 20 years: Because in the bed they are always kept in an almost equal temper of heat, who had they been exposed to the excesses of heat and cold, would not probably have survived one.

Seeing then, this best posture which our reason could make choice of, we see really established in nature, we cannot but acknowledge it to be the issue of wisdom, counsel, and providence. Moreover, a further argument to evince this is, That tho' it cannot be acknowledged, that if the *Axis* of the earth were perpendicular to the plane of the ecliptic, her motion would be more easy and natural, yet notwithstanding, for the conveniences fore-mentioned, we see it is made in an inclining posture.

Another very considerable, and heretofore unobserved convenience of this inclination of the earth's *Axis*, Mr. Keill affords us in *his examination of Dr. Burnet's Theory of the earth* p. 69.

There is (saith he) one more [besides what he had mentioned before] considerable advantage, which we reap by the present position of the earth,

which I will here insert, because I do not know that it is taken notice of by any; and it is, that by the present inclination of the earth's *Axis* to the plane of the *Ecliptic*, we who live beyond 45 degrees of latitude, and stand most in need of it, have more of the sun's heat throughout the year than if he had shined always in the *Equator*; that is, if we take the sum of the sun's actions upon us both in Summer and Winter, they are greater than its heat would be if he moved always in the *Equator*; or, which is the same thing, the aggregate of the sun's heat upon us while he describes any two opposite parallels, is greater than it would be if in those two days he described the *Equator*; whereas in the *Torrid Zone*, and even in the temperate, almost as far as 45 degrees of latitude, the sum of the sun's heat in Summer and Winter is less than it would be, were the *Axis* of the earth perpendicular to the plane of the *Ecliptic*; for the demonstration of which I refer the reader to the book itself.

I think (proceeds he) this consideration cannot but lead us into a transcendent admiration of the *divine Wisdom*, which hath placed the earth in such a posture, as brings with it several conveniences beyond what we can easily discover without study and application; and I make no question, but if the rest of the *Works of Nature* were well observed, we would find several advantages which accrue to us by their present constitution, which are far beyond the uses of them that are yet discovered; by which it will plainly appear, that God hath chosen better for us than we could have done for ourselves.

If any man should object and say, it would be more convenient for the inhabitants of the earth if the Tropicks stood at a greater distance, and the sun moved further northward and southward, for  
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so the north and south parts would be relieved, and not exposed to so extreme cold, and thereby rendered uninhabitable, as now they are :

To this I answer, That this would be more inconvenient to the inhabitants of the *Earth* in general, and yet would afford the *North* and *South* parts but little more comfort ; for then as much as the distances between the *Tropicks* were enlarged, so much would also the *Artic* and *Antartic* circles be enlarged too ; and so we here in *England*, and so on northerly, should not have that grateful and useful succession of day and night, but proportionably to the sun's coming towards us, so would our days be of more than twenty-four hours length ; and according to his recess in Winter, our nights proportionable ; which how great an inconvenience it would be, is easily seen ; whereas now the whole latitude of the earth, which hath at any time above twenty-four hours day and twenty-four hours night, is little and inconsiderable in comparison of the whole bulk, as lying near the *Poles* ; and yet neither is that part altogether unuseful, for in the waters there live fishes, which other-where are not obvious ; so we know the chief *Whale-fishing* is in *Greenland* ; yea, not only fish, but great variety of water-fowl, both whole and cloven-footed, frequent the waters, and feed there, breeding also on the cliffs by the sea-side, as they do with us ; the figures and descriptions of a great many whereof are given us by *Martin* in his voyage to *Spitzberg*, or *Greenland* ; and on the land *Bears*, and *Foxes*, and *Deer*, in the most northerly country that was ever yet touched ; and doubtless, if we shall discover further to the very *North Pole*, we shall find all that tract not to be vain, useless, or unoccupied.

*Thirdly*, The third and last thing I proposed was, the constitution and consistency of the parts

of the earth. And first, admirable it is that the waters should be gathered together into such great *Conceptacula*, and the dry land appear; and tho' we had not been assured thereof by divine revelation, we could not in reason but have thought such a division and separation to have been the work of omnipotency, and infinite wisdom and goodness; for in this condition the water nourishes and maintains innumerable multitudes of various kinds of fishes, and the dry land supports and feeds as great variety of plants and animals, which have their firm footing and habitation; whereas had all been *Earth*, all the species of *Fishes* had been lost, and all those commodities which the water affords us; or all *Water*, there had been no living for plants, or terrestrial animals, or man himself, and all the beauty, glory and variety of this inferior world had been gone, nothing being to be seen, but one uniform dark body of water; or had all been mixed and made up of water and earth into one body of mud or mire, as one would think should be most natural; for why such a separation as at present we find should be made, no account can be given but providence; I say, had all this globe been mire or mud, then could there have been no possibility for any animals at all to have lived, excepting some few, and those very dull and inferior ones too. That therefore the *Earth* should be made thus, and not only so, but with so great variety of parts, as mountains, plains, vallies, sand, gravel, lime, stone, clay, marble, argilla, &c. which are so delectable and pleasant, and likewise so useful and convenient for the breeding and living of various plants and animals, some affecting mountains, some plains, some vallies, some watery places, some shade, some sun, some clay, some sand, some gravel, &c. That the earth should be so figured as to have mountains in  
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the mid-land parts, abounding with springs of water, pouring down streams and rivers for the necessities and conveniences of the inhabitants of the lower countries, and that the levels and plains should be formed with so easy a declivity as to cast off the water, and yet not render travelling or tillage very difficult or laborious; these things, I say, must needs be the result of counsel, wisdom, and design; especially when (as I said before) not that way which seems more facile and obvious to chance is chosen, but that which is more difficult and hard to be traced, when it is most convenient and proper for those nobler ends and designs which were intended by its wise Creator and governor. Add to all this, that the whole dry land is, for the most part, covered over with a lovely carpet of green grass, and other herbs, of a colour not only most grateful and agreeable, but most useful and salutary to the eye; and this also decked and adorned with great variety of flowers of beautiful colours and figures, and of most pleasant and fragrant odours, for the refreshment of our spirits and our innocent delight; as also with beautiful shrubs and stately trees, affording us not only pleasant and nourishing fruits, many liquors, drugs, and good medicines, but timber, and utensils for all sorts of trades and the conveniences of man; out of many thousands of which we will only just name a few, lest we should be tedious and too bulky.

*First, The Coco, or Coker-nut tree, that supplies the Indians with almost whatever they stand in need of, as bread, water, wine, vinegar, brandy, milk, oil, honey, sugar, needles, thread, linen, clothes, cups, spoons, besoms, baskets, paper, masts for ships, sails, cordage, nails, covering for their houses, &c. which may be seen at large in the many printed relations of voyages and travels to the East-Indies, but most faithfully*



ly in the *Hortus Malabaricus*, published by that immortal patron of natural learning, *Henry Van Reede Van Draakenstein*, who has had great commands and employs in the *Dutch colonies*.

Secondly, The *Aloe Muricata, vel Aculeata*, which yields the *Americans* every thing their necessities require, as fences and houses, darts, weapons, and other arms, shoes, linen, and clothes, needles and thread, wine and honey, besides many utensils; for all which *Hernandes, Garcilasso de la Vega*, and *Margrave*, may be consulted.

Thirdly, The *Bandura Gingalensium*, called by some the *Priapus Vegetabilis*, at the end of whose leaves hang long sacks or bags, containing a pure limpid water, of great use to the *Natives* when they want rain for eight or ten months together.

Aparallel instance to this of the *Bandura*, my learned and worthy friend *Dr. Sloane* affords us in a plant by him observed in the island of *Jamaica*, and described by the title of *Viscum Caryophylloides maximum flore tripetalo pallide luteo, femine filamentoso*, which is commonly called in that island, *Wild Pine*. *Philosoph. Transact. No 251. Page 144*. I shall not transcribe the whole description, but only that part of it which relates to this particular: "From the root (which he had described before) arise leaves on every side, after the manner of leeks, or *Anana's*, whence the name of *Wild-pine*, or *Aloes*, being folded or inclosed one with another, each of which is two foot and an half long, and from a three inch breadth at beginning, or base ends in a point, having a very hollow or concave inward side, and a round or convex outward one: So that by all their hollow sides is made within a very large preservatory cistern or basin, fit to contain a pretty quantity of water, which in the rainy season falls upon the ut-

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"most parts of the spreading leaves, which have  
"chanelled in them, conveying it down to the ci-  
"stern where it is kept, as in a bottle, the leaves,  
"after they are swelled out like a bulbous root  
"to make the bottle, bending inward or coming  
"again close to the stalk, by that means hindring  
"the evaporation of the water, by the heat of the  
"sun-beams.

"In the mountainous, as well as the dry low  
"woods, in scarcity of water, this reservatory is  
"not only necessary and sufficient for the nou-  
"rishment of the plant itself, but likewise is very  
"useful to men, birds, and all sorts of insects,  
"whether in scarcity of water they come in  
"troops, and seldom go away without refresh-  
"ment.

"Captain *Dampier*, in his voyages, *Vol. II.*  
"of *Campeche*, tells us, That these basons made  
"of the leaves of the *Wild-pine*, will hold a pint  
"and half or a quart of water, and that when  
"they find these *Pines*, they stick their knives  
"into the leaves just above the roots, and that  
"lets out the water, which they catch in their  
"hats, as (saith he) I have done many times, to  
"my great relief."

*Fourthly*, The *Cinnamon-tree* of *Ceylon*, in whose  
parts there is a wonderful diversity: Out of the  
root they get a sort of *Camphire*, and its oil;  
out of the bark of the trunk, the true oil of  
*Cinnamon*; from the leaves, an oil like that of  
*Cloves*; out of the fruit, a *Juniper* oil, with a  
mixture of those of *Cinnamon* and *Cloves*; besides,  
they boil the berries into a sort of wax, out of  
which they make candles, plaisters, unguents.  
Here we may take notice of the *Candle-trees* of  
the *West-Indies*, out of whose fruit, boiled to a  
thick fat consistence, are made very good candles,  
many

many of which have been lately distributed by that most ingenious merchant, Mr. *Charles Dubois*.

*Fifthly*, The *Fountains*, or *Dropping-trees*, in the isles of *Ferro*, *St. Thomas*, and in *Guiney*, which serve the inhabitants instead of rain, and fresh springs: My honoured friend, Dr. *Tanner Robinson*, in a late letter to me, is not of *Vossius's* opinion, that these trees are of the *Ferulaceous* kind, because he observes, that by the descriptions of eye-witnesses, and by the dried sample sent by *Paludanus* to the duke of *Wirtemberg*, the leaves are quite different from those of the *Ferula's*, coming nearer to the *Seseli Ethiopium Salicis vel Periclymeni folio*: Therefore the *Doctor* rather thinks them to be of the *Laurel-kind*, though he concludes there may be many different sorts of these running Aqueous trees; because that *Phænomenon* does not depend upon, or proceed from any peculiarity of the plant, but rather from the place and situation; of which he writes more at large, in a letter printed in another discourse of mine.

*Sixthly*, and *Lastly*, We will only mention the names of some other vegetables, which, with eighteen or twenty thousand more of that kind, do manifest to mankind the illustrious bounty and providence of the Almighty and omniscient Creator, towards his undeserving creatures; as the *Cotton-Trees*, the *Manioc*, or *Cassava*; the *Potatoe*; the *Jesuit's-bark tree*; the *Poppy*; the *Rhubarb*; the *Scammony*; the *Jalap*; the *Colloquintida*; the *China*; *Sarsa*; the *Serpentaria Virginiana*, or *Snake-weed*; the *Nisi*, or *Genseng*; the *Numerous Balsam*, and *Gum-trees*; many of which are of late much illustrated by the great industry and skill of that most discerning botanist, Dr. *Leonard Plukenet*. Of what great use all these, and innumerable other plants, are to mankind in the several

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parts of life, few or none can be ignorant; besides the known uses in curing diseases, in feeding and cloathing the poor, in building, in dying: In all mechanicks there may be as many more not yet discovered, which may be reserved on purpose to exercise the faculties bestowed on man, to find out what is necessary, convenient, pleasant, or profitable to him.

To sum up all in brief: This *Terraqueous* globe we know is made up of two parts;

1. A thin and fluid.
2. A firm and consistent.

The former called by the name of *Water*; the latter, of *Earth*, or *Dry Land*. The *Land*, being the more dense and heavy body, doth naturally descend beneath the water, and occupy the lower place; the water ascends and floats above it. But we see that it is not thus: For the *Land*, though the more heavy, is forcibly and contrary to its nature so elevated as to cast off the water, and stand above it, being (as the Psalmist phrases it) *founded upon or above the seas, and established above the floods*, Psalm xxiv. 2. and this in such manner, that not only on one side of the globe, but on all sides, there were probably continents and islands, raised so equally as to counterbalance one another, the water flowing between them, and filling the hollow and depressed places; neither was the dry land only raised up and made to appear, but some parts (which we call mountains) were highly elevated above others, and those so dispos'd and situated (as we have shewn) in the mid-land parts, and in continued chains running *East and West*, as to render all the earth habitable, a great part whereof otherwise would not have been so; but the *Torrid Zone* must indeed have been such a place as the ancients fancied it, uninhabitable for heat. Let us now consider how much better it is that the dry land

land should be thus raised up, and the globe divided almost equally between earth and water, than that all its surface should be one uniform and dark body of water; I say water, because that naturally occupies the superior place, and not earth; for were it all water, the whole beauty of this inferior world were gone; there could be no such pleasant and delicious prospects as the earth now affords us; no distinction, and grateful variety of mountains and hills, plains and vallies, rivers and pools, and fountains; no shady woods, stored with lofty and towering trees for timber, lowly and more spread ones for shade and fruit; no amiable verdure of herbs, bespangled with an infinite variety of specious and fragrant flowers; for those plants that grow at the bottom of the sea, are for the most part of a dull, sullen, and dirty olive colour, and bear no flowers at all; instead of the elegant shapes and colours, the sagacity and docility of ingenious beasts and birds, the musical voices and accents of the aëreal Choristers, there had been nothing but mute, and stupid, and indocile fishes, which seem to want the very sense of discipline, as may be gathered from that they are not vocal, and that there appear in them no organs of hearing, it being also doubtful whether the element they live in be capable of transmitting sounds; the best sense they have, even their sight, can be but dull and imperfect, the element of water being semi-opake, and reflecting a good part of the beams of light; the most noble and ingenious creatures that live there, the cetaceous kind, being near akin to terrestrial animals, and breathing in the same element, the open air. Had, I say, all been water, there had been no place for such a creature as man, as we see there is no such there; there is no business for him, no subject to employ his art and faculties, and consequently there could be no effects

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effects of them; no such things as houses and cities, and stately edifices; as gardens and orchards, and walks, and labyrinths; as corn-fields and vineyards, and the rest of these ornaments, wherewith the wit and industry of man hath embellished the world.

These are great things, and worthy the care and providence of the Creator; which whoso considereth, and doth not discern and acknowledge, must needs be as stupid as the earth he goes upon.

But because mountains have been looked upon by some as warts, and superfluous excrescencies, of no use or benefit, nay, rather as signs and proofs that the present earth is nothing else but a heap of rubbish and ruins, I shall reduce and demonstrate in particulars the great use, benefit, and necessity of them.

I. They are of eminent use for the production and original of springs and rivers; without hills and mountains there could be no such things, or at least but very few, no more than we now find in plain and level countries, that is, so few, that it was never my hap to see one; in Winter-time indeed we might have torrents and land-floods, and perhaps sometimes great inundations; but in Summer nothing but stagnating water, reserved in pools and cisterns, or drawn up out of deep wells; but as for a great part of the earth (all lying within or near the tropicks) it would neither have rivers, nor any rain at all; we should consequently lose all those conveniences and advantages that rivers afford us, of fishing, navigation, carriage, driving of mills, engines, and many others. This end of mountains I find assigned by Mr. Edmund Halley, a man of great sagacity and deep insight into the natures and causes of things, in a discourse of his published in the *Philosoph. Transact.* Numb. 192. in these words: *This, if we may allow*



allow final causes [Hardiment, The thing is clear, pronounce boldly, without any *I*s or *And*s] *This seems to be one design of the hills, that their ridges being placed through the midst of their continents, might serve as it were for alembicks, to distil fresh water for the use of man and beast; and their heights to give a descent of those streams; to run gently, like so many veins of the Microcosm, to be the more beneficial to the creation.*

II. They are of great use for the generation, and convenient digging up of metals and minerals; which how necessary instruments they are of culture and civility, I have before shewn; these we see are all digged out of mountains, and I doubt whether there is or can be any generation of them in perfectly plain and level countries; but if there be, yet could not such mines, without great pains and charges, if at all, be wrought; the dells would be so flown with waters (it being impossible to make any *Addits* or *Soughs* to drain them) that no gins or machines could suffice to lay and keep them dry.

III. They are used to mankind in affording them convenient places for habitation, and situations of houses and villages, serving as skreens to keep off the cold and nipping blasts of the *Northern* and *Easterly* winds, and reflecting the benign and cherishing sun-beams, and so rendring their habitations both more comfortable and more chearly in Winter; and promoting the growth of herbs and fruit-trees, and the maturation of their fruits in Summer; besides casting off the waters, they lay the gardens, yards, and avenues to the houses dry and clean, and so as well more salutary as more elegant; whereas houses built in plains, unless shaded with trees, lie bleak, and exposed to wind and weather, and all Winter are apt to be grievously annoyed with mire and dirt.

IV.

IV. They are very ornamental to the earth, affording pleasant and delightful prospects, both, 1. To them that look downwards from them upon the subjacent countries, as they must needs acknowledge who have been but on the downs of *Sussex*, and enjoyed that ravishing prospect of the sea on one hand, and the country far and wide on the other. And, 2. To those that look upwards, and behold them from the plains and low grounds, which what a refreshing and pleasure it is to the eye, they are best able to judge who have lived in the isle of *Ely*, or other level countries, extending on all sides further than one can ken; or have been out far at sea, where they can see nothing but sky and water. That the mountains are pleasant objects to behold, appears, in that the very images of them, their draughts and landskips, are so much esteemed.

V. They serve for the production of great variety of herbs and trees, for it is a true observation, that mountains do especially abound with different species of vegetables, because of the great diversity of soils that are found there, every *Vertex* or eminency almost affording a new kind. Now these plants serve partly for the food and sustenance of such animals as are proper to the mountains, partly for medicinal uses, the chief physick herbs and roots, and the best in their kinds, growing there; it being remarkable that the greatest and most luxuriant *Species* in the most *Genera* of plants are native of the mountains; partly also for the exercise of such ingenious and industrious persons as are delighted in searching out these natural rarities, and observing the outward form, growth, natures and uses of each species, and reflecting upon the Creator of them his due praises, and benedictions.

VI. They serve for the harbour, entertainment, and maintenance of various animals, birds, beasts, and

and insects, that breed, feed, and frequent there; for the highest tops and pikes of the *Alps* themselves are not destitute of their inhabitants; the *Ibex*, or *Stein-buck*, the *Rupicapra* or *Chamois* among quadrupeds; the *Lagopus* among birds; and I myself have observed beautiful *Papilio's*, and store of other insects, upon the tops of some of the *Alpine* mountains; nay, the highest ridges of many of those mountains serve for the maintenance of cattle for the service of the inhabitants of the valleys; the men there, leaving their wives and younger children below, do not without some difficulty clamber up the acclivities, dragging their kien with them, where they feed them, and milk them, and make butter and cheese, and do all the dairy-work, in such sorry hovels and shades as they build there to inhabit in during the summer months; this I myself have seen and observed in mount *Jura*, not far from *Geneva*, which is high enough to retain snow all the Winter.

The same they do also in the *Grifons* country, which is one of the highest parts of the *Alps*, travelling through which I did not set foot off snow for four days journey, at the latter end of *March*.

VII. Those long ridges and chains of lofty and topping mountains which run through the whole continents *East* and *West* (as I have elsewhere observed) serve to stop the evagation of the vapours to the *North* and *South* in hot countries, condensing them, like alembick heads, into water, and so by a kind of external distillation giving original to springs and rivers; and likewise by amassing, cooling, and constipating of them, turn them into rain; by those means rendring the servid regions of the *Torrid Zone* habitable.

\* *The Dissolution of the World.*

This discourse concerning the use of mountains, I have made use of in another \* Treatise; but because it



is proper to this place, I have (with some alterations and enlargements) here repeated it.

I had almost forgotten that use they are of to mankind, in serving for boundaries and defences to the territories of kingdoms and commonwealths.

A second particular I have made choice of more exactly to survey and consider, is the body of man; wherein I shall endeavour to discover something of the wisdom and goodness of God: First, by making some general observations concerning the body. Secondly, By running over and discourting upon its principal parts and members.

1. Then, in general, I say, the wisdom and goodness of God appears in the *erect Posture* of the body of man, which is a privilege and advantage given to man above other animals; but tho' this be so, yet I would not have you think that all the particulars I shall mention are proper only to the body of man, divers of them agreeing to many other creatures. It is not my business to consider only the prerogatives of man above other animals, but the endowments and perfections which nature hath conferred on his body, tho' common to them with him. Of this *Erection* of the *Body* of man the ancients have taken notice, as a particular gift and favour of God,

*Pronaque cum spectent animalia cætera terram,  
Os homini sublime dedit, cælumque tueri  
Jussit, & erectos ad Sydera tollere vultus.*

Ovid. Metam. 1.

And before him, Tully in his second book, *De Nat. Deorum*;

*Ad hanc providentiam naturæ tam diligentem  
tamque solertem adjungi multa possunt, e quibus  
intelligatur quantæ res hominibus a Deo, quam-  
que eximiæ tributæ sunt, qui primum eos humo*

*excitatos, celfos & erectos constituit, ut Deorum cognitionem cælum intuentes capere possent. Sunt enim e terra homines, non ut incolæ atque habitatores, sed quasi spectatores superarum rerum atque cœlestium, quarum spectaculum ad nullum aliud genus animantium pertinet.*

Man being the only creature in this sublunary world made to contemplate heaven, it was convenient that he should have such a figure, or *Situs* of the parts of his body, that he might conveniently look upwards. But to say the truth in this respect, of contemplating the heavens, or looking upwards, I do not see what advantage a man hath by this erection above other animals, the faces of most of them being more supine than ours, which are only perpendicular to the Horizon, whereas some of theirs stand reclining; but yet two or three other advantages we have of this erection, which I shall here mention.

*First*, It is more commodious for the sustaining of the head, which being full of brains, and very heavy (the brain in man being far larger, in proportion to the bulk of his body, than in any other animal) would have been very painful and wearisome to carry, if the neck had lain parallel or inclining to the Horizon.

*Secondly*, This figure is most convenient for prospect, and looking about one; a man may see further before him, which is no small advantage for avoiding danger, and discovering whatever he searches after.

*Thirdly*, The conveniency of this site of our bodies will more clearly appear, if we consider what a pitiful condition we had been in, if we had been constantly necessitated to stand and walk upon all four; man being, by the make of his body, of all quadrupeds (for now I must compare him with them) the most unfit for that kind of *Incessus*, as I shall shew anon; and besides that, we should

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have wanted, at least in a great measure, the use of our hand, that invaluable instrument, without which we had wanted most of those advantages we enjoy as reasonable creatures, as I shall more particularly demonstrate afterwards.

But it may be perchance objected by some, that nature did not intend this erection of the body, but that it is superinduced and artificial; for that children at first creep on all four, according to that of the poet;

*Mox quadrupes, ritumque tulit sua membra ferarum.*  
Ovid.

To which I answer, that there is so great an inequality in the length of our legs and arms, as would make it extremely inconvenient, if not impossible for us to walk upon all four, and set us almost upon our heads; and therefore we see that children do not creep upon their hands and feet, but upon their hands and knees; so that it is plain that nature intended us to walk as we do, and not upon all four.

2. I argue from the *Situs*, or position of our faces; for had we been to walk upon all four, we had been the most prone of all animals, our faces being parallel to the Horizon, and looking directly downwards.

3. The greatness and strength of the muscles of the thighs and legs above those of the arms, is a clear indication that they were by nature intended for a more difficult and laborious action, even the moving and transferring the whole body, and that motion to be sometimes continued for a great while together.

As for that argument taken from the contrary flexure of the joints of our arms and legs to that of quadrupeds, as that our knees bend forward, whereas the same joint of their hind legs bends back.



backward; and that our arms bend backward, whereas the knees of their fore-legs bend forward; although the observation be as old as *Aristotle*, because I think there is a mistake in it, in not comparing the same joints (for the first and uppermost joint in a quadruped's hind-legs bends forward as well as a man's knees, which answer to it, being the uppermost joint of our legs, and the like *mutatis mutandis* may be said of the arms) I shall not insist upon it.

Another particular which may serve to demonstrate that this erect posture of the body of man was intended and designed by the wise and good author of nature, is the fastning of the cone of the *Pericardium* to the midriff, an account whereof I shall give the reader out of the ingenious Dr. *Tyson's Anatomy of the Orang-Outang, or Pigmie*, p. 49.

*Vesalius* (saith he) and others make it a peculiarity to man, that the *Pericardium*, or bag that incloses the heart, should be fastned to the *Diaphragm*: *Vesalius* tells us (*De Corporis Humani fabrica*, lib. 6. cap. 8.) *Cæterum involucrum mucro, & dextri ipsius lateris egregia portio septi transversi nerveo circulo validissime amplexu admodum spatio connascitur, quod hominibus est peculiare. The point of the Pericardium, and a very considerable portion of its right side, is most firmly fastned to the nervous circle of the midriff for a large space, which is peculiar to mankind.* So *Blancardius*, *Anat. Reformat.* cap. 2. p. 8. *Homo præ cæteris animalibus hoc peculiare habet, quod ejus pericardium septi transversi medio semper accrescat, cum idem in quadrupedum genere liberum & aliquanto spatio ab ipso remotum sit: Man hath this peculiar to him; and different from other animals, that his Pericardium doth always grow to the middle of the midriff; whereas in the quadruped kind it is free, and removed some distance from it.*

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The *Pericardium* in man is therefore thus fastened, that in *Expiration* it might assist the *Diaſtole* of the *Diaphragm*, for otherwise the liver and stomach being ſo weighty, they would draw it down too much towards the *Abdomen*, ſo that upon the relaxation of its fibres in its *Diaſtole* it would not aſcend ſufficiently into the *Thorax*, ſo as to cauſe a ſubſidency of the lungs, by leſſening the cavity there. In *Quadrupeds* there is no need of this adheſion of the *Pericardium* to the *Diaphragm*, for in them in *Expiration*, when the fibres of the *Diaphragm* are relaxed, the weight of the *Viſcera* of the *Abdomen* will eaſily preſs the *Diaphragm* up into the cavity of the *Thorax*, and ſo perform that ſervice; beſides, were the *Pericardium* faſtened to the *Diaphragm* in *Quadrupeds*, it would hinder its *Syſtole* in *Inſpiration*, or its deſcent downwards upon the contraction of its *Muſcular Fibres*, and the more, becauſe the *Diaphragm* being thus tyed up, it could not then ſo freely force down the weight of the *Viſcera*, which are always preſſing upon, it and conſequently not ſufficiently dilate the cavity of the *Thorax*, and therefore muſt hinder their *Inſpiration*. Thus we ſee how neceſſary it is that in *Man* the *Pericardium* ſhould be faſtened to the *Diaphragm*, and in *Quadrupeds* how inconvenient it would be. And ſince we find this difference between the hearts of brutes and men in this particular, how can we imagine but that it muſt needs be the effect of wiſdom and deſign, and that man was intended by nature to walk erect, and not upon all four, as quadrupeds do?

II. The body of man may thence be proved to be the effect of wiſdom, becauſe there is nothing in it deficient, nothing ſuperfluous, nothing but hath its end and uſe. So true are thoſe maxims we have already made uſe of: *Natura nihil facit fruſtra*, and *Natura non abundat in ſuperfluis, nec deficit in neceſſariis*, no part that we can well ſpare.

spare. *The eye cannot say to the hand, I have no need of thee; nor the head to the feet, I have no need of you,* 1 Cor. xii. 21. that I may usurp the Apostle's similitude.

The belly cannot quarrel with the members, nor they with the belly for her seeming sloth: as they provide meat for her, so she concocts and distributes it to them; only it may be doubted to what use the *Paps* in men should serve. I answer, partly for ornament, partly for a kind of conformity between the sexes, and partly to defend and cherish the heart; in some they contain milk, as in a *Danish* family we read of in *Bartholine's Anatomical Observations*; however, it follows not that they or any other parts of the body are useless because we are ignorant.

I have lately met with a story in Signior *Paulo Boccone's natural Observations*, printed at *Bologna* in *Italy* 1684, well attested, concerning a countryman called *Billardino di Billo*, living in a village belonging to the city of *Nocera* in *Umbria*, called *Somareggio*; whose wife dying, and leaving a young infant, he nourished it with his own milk. This man, either because in the small village where he lived there was not a wet nurse to be had, or because he was not able to hire one, took the child, and applying it to his own bosom, and putting the nipples of his breasts into its mouth, invited it to suck, which the infant did, and after divers times drawing, fetched some milk; whereat the father encouraged, continued to apply it, and so after a while it brought down the milk so plentifully as to nourish it for many months, till it was fit to be weaned. Hereupon my author, having proved by sufficient authority of able anatomists, such as *Franciscus Maria Florentinus*, and *Marcellus Malpighius*, that the paps of men have the same structure and the same vessels with those of women, concludes, that nature hath not given

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paps to men either to no purpose, or for mere ornament, but, if need requires, to supply the defect of the female, and give suck to the young.

Had we been born with a large wen upon our faces, or a *Bavarian* poke under our chins, or a great bunch upon our backs like *Camels*, or any the like superfluous excrescency, which should be not only useless but troublesome, not only stand us in no stead, but also be ill-favoured to behold and burdensome to carry about, then we might have had some pretence to doubt whether an intelligent and bountiful Creator had been our architect: for had the body been made by chance, it must in all likelihood have had many of these superfluous and unnecessary parts.

But now seeing there is none of our members but hath its place and use, none that we could spare, or conveniently live without, were it but those we account excrements, the hair of our heads, or the nails on our fingers ends, we must needs be mad or sottish, if we can conceive any other than that an infinitely good and wise God was our author and former.

III. We may fetch an argument of the wisdom and providence of God from the convenient situation and disposition of the parts and members of our bodies; they are seated most conveniently for use, for ornament, and for mutual assistance.

*First*, For use. So we see the senses, of such eminent use for our well being, situate in the head, as sentinels in a watch-tower, to receive and convey to the soul the impressions of external objects. *Sensus autem interpretes ac nuntii rerum in capite tanquam in arce mirifice ad usus necessarios & facti & collocati sunt.* Cic. de Nat. Deorum. The eye can more easily see things at a distance, the ear receive sounds from afar; how could the eye have been better placed, either for beauty and ornament, or for the guidance and direction of the whole

whole body; As *Cicero* proceeds well, *Nam oculi tanquam speculatores altissimum locum obtinent, ex quo plurima conspicientes funguntur suo munere: Et aures quæ sonum recipere debent, qui natura in sublime fertur, recte in altis corporum partibus collocatæ sunt; itemque nares, eo quod omnis odor ad superiora fertur, recte sursum sunt.* For the eyes, like sentinels, occupy the highest place, from whence seeing many things, they perform their functions; and the ears, which are made for the reception of sounds, which naturally are carried upwards, are rightly placed in the uppermost parts of the body: also the nostrils, because all odours ascend, are fitly situate in the superior parts. I might instance in the other members; how could the hands have been more conveniently placed for all sorts of exercises and works, and for the guard and security of the head and principal parts; the heart, to dispense life and heat to the whole body, viz. near the centre? and yet because it is harder for the blood to ascend than descend, somewhat nearer the head? It is also observable, that the sinks of the body are removed as far from the nose and eyes as may be, which *Cicero* takes notice of in the fore-mentioned place: *Ut in ædificiis architecti avertunt ab oculis & naribus dominorum ea quæ profluentia necessario essent tetri aliquid habitura, res similes procul amandavit a sensibus.*

Secondly, For ornament: What could have been better contrived, than that those members which are pairs, should stand by one another in equal altitude, and answer on each side one to another? And,

Thirdly, For mutual assistance. We have before shewed how the eye stands most conveniently for guiding the hand, and the hand for defending the eye; and the like may be said of the other parts, they are so situate as to afford direction and help one to another; this will appear more clear

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clearly, if we imagine any of the members situ-  
ate in contrary places or positions. Had a man's  
arms been fitted only to bend backwards behind  
him, or his legs only to move backwards, what  
direction could his eyes then have afforded him in  
working or walking? or how could he then have  
sed himself; nay, had one arm been made to bend  
forward, and the other directly backward, we had  
then lost half the use of them, since they could  
not have assisted one the other in any action. Take  
the eyes, or any other of the organs of sense, and  
see if you can find any so convenient a seat for  
them in the whole body as that they now possess.

IV. From the ample provision that is made for  
the defence and security of the principal parts;  
those are, 1. The *Heart*, which is the fountain of  
life and vegetation, *Officina spirituum vitalium*,  
*principium & fons caloris nativi*, *lucerna humidæ*  
*radicalis*; and that I may speak with the Chymists,  
*Ipse sol microcosmi*, the very *Sun of the Microcosm*,  
or little world, in which is contained that vital  
flame, or heavenly fire, which *Prometheus* is  
fabled to have stole from *Jupiter*; or, as *Aristotle*  
phrases it, that *Ἀνάλογον τῷ τῶν ἀπλανῶν στοιχείῳ*. *Di-*  
*vinum quid respondens elemento stellarum*. This  
for more security is situate in the centre of the  
trunk of the body, covered first with its own  
membrane, called *Pericardium*, lodged within the  
soft bed of the lungs, encompassed round with a  
double fence. (1.) Of firm bones or ribs, to bear  
off blows: (2.) Of thick muscles and skins, be-  
sides the arms conveniently placed, to fence off  
any violence at a distance, before it can approach  
to hurt it. 2. The *Brain*, which is the prin-  
ciple of all sense and motion, the fountain of  
the animal spirits, the chief seat and palace royal  
of the soul, upon whose security depends what-  
ever privilege belongs to us as sensitive or rational  
creatures; this, I say, being the prime and im-  
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mediate organ of the soul, from the right constitution whereof proceeds the quickness of apprehension, acuteness of wit, solidity of judgment, method and order of invention, strength and power of memory (which if once weakned and disordered, there follows nothing but confusion and disturbance in our apprehensions, thoughts and judgment) is environed round about with such a potent defence, that it must be a mighty force indeed that is able to injure it.

1. A skull, so hard, thick and tough, that it is almost as easy to split a helmet of iron as to make a fracture in it. 2. This is covered with skin and hair, which serve to keep it warm, being naturally a very cold part, and also to quench and dissipate the force of any stroke that shall be dealt it, and retund the edge of any weapon. 3. And yet more than all this, there is still a thick and tough membrane, which hangs looser about it, and doth not so closely embrace it (that they call *Dura Mater*) and in case the skull happens to be broken, doth often preserve it from injury and diminution, And lastly, a thin and fine membrane, strait, and closely adhering, to keep it from quashing and shaking. The many pairs of nerves proceeding from it, and afterwards distributing and branching themselves to all the parts of the body, either for nutrition or motion, are wonderful to behold in prepared bodies, and even in the schemes and figures of Dr. *Willis* and *Vieussens*.

I might instance (3.) in the *Lungs*, which are so useful to us as to life and sense, that the vulgar think our breath is our very life, and that we breathe out our souls from thence; suitable to which notion both *Anima* and *Spiritus* in *Latin*, and *πνεῦμα* in *Greek*, are derived from words that signify breath and wind; and *efflare*, or *exhalare animam*, signify to die. And the old *Romans* used to apply mouth to mouth and re-

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ceive the last gasps of their dying friends, as if their souls had come out that way; from hence perhaps might first spring that opinion of the vehicles of spirits; the vulgar, as I hinted before, conceiving that the breath was, if not the soul itself, yet that wherein it was waisted and carried away. These *Lungs*, I say, are, for their better security and defence, shut up in the same cavity with the heart.

V. In the abundant provision that is made against evil accidents and inconveniencies. And the liberality of nature as to this particular appears, 1. In that she hath given many members (which are of eminent use) by pairs, as two eyes, two ears, two nostrils, two hands, two feet, two breasts [*Mammæ*] two reins; that so, if by any cross or unhappy accident one should be disabled or rendered useless, the other might serve us tolerably well; whereas had a man but one hand or one eye, &c. if that were gone, all were gone, and we left in an evil case. See then and acknowledge the Benignity of the Deity, who hath bestowed upon us two hands and two eyes, and other the like parts, not only for our necessity but conveniency so long as we enjoy them, and for our security in case any mischance deprive us of one of them. 2. In that all the vessels of the body have many ramifications, which particular branches, tho' they serve mainly for one member or muscle, yet send forth some twigs to the neighbouring muscles, and so interchangeably the branches that serve these send to them; so that if one branch chance to be cut off or obstructed, its defect may in some measure be supplied by the twigs that come from the neighbouring vessels. 3. In that she hath provided so many ways to evacuate what might be hurtful to us, or breed diseases in our bodies; if any thing oppresses the head, it hath a power to free itself by sneezing; if any thing fall into the lungs, or if

any humour be discharged upon them, they have a faculty of clearing themselves and casting it up by coughing; if any thing clog or burden the stomach, it hath an ability of contracting itself and throwing it up by vomit. Besides these ways of evacuation, there are siege, urine, sweating, *Hæmorrhages* from the nose, and *Hæmorrhoidal* veins, fluxes of rheum. Now the reason why nature hath provided so many ways of evacuation is, because of the different humours that are to be voided or cast out; when therefore there is a secretion made of any noxious humour, it is carried off by that emunctory, whose pores are fitted to receive and transmit the minute parts of it; if at least this separation be made by percolation, as we will now suppose, but not assert, yet I doubt not but the same humour may be cast off by divers emunctories, as is clear in urine and sweat, which are for the main the same humour carried off several ways.

To this head of provision against inconveniences, I shall add an observation or two concerning sleep.

1. Sleep being necessary to man and other animals for their refreshment, and for the reparation of that great expence of spirits which is made in the day-time by the constant exercise of the senses and motions of the muscles, that it might ease and refresh us indeed, nature hath provided, that tho' we lie long upon one side, we should have no sense of pain or uneasiness during our rest, no, nor when we awake; whereas in reason one would think, that the whole weight of the body pressing the muscles and bones on which we lie, should be very burdensome and uneasy, and create a grievous sense of pain; and we find by experience that it doth so when we lie long awake in the night, we being not able (especially if never so little indisposed) to rest one quarter of an hour in the same posture without shifting of sides, or at least etch-

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ing this way and that way, more or less. How this may be effected, is a great question. To me it seems most probable that it is done by an inflation of the muscles, whereby they become both soft, and yet renitent, like so many pillows, dissipating the force of the pressure, and so preventing or taking away the sense of pain. That the muscles are in this manner inflated in time of rest, appears to the very eye in the faces of children, and may be proved from that, when we rest in our cloaths we are fain to loosen our garters, shoe-strings, and other ligatures, to give the spirits free passage, else we shall experience pain and uneasiness in those parts, which when we are walking we find not.

The reason of this *Phænomenon*, viz. that *anæsthesia*, or want of pain we experience in sleep, during and after a long *decubitus* on one side, Dr. Lister in his *Journey to Paris*, p. 113. and Dr. Jones in his treatise of *The mysteries of Opium revealed*, attribute to the relaxation of the nerves and muscles in time of sleep; and the sense of pain and uneasiness when we lie awake, to the tension of them during that time: This I do not deny, but yet I think the reason I have assigned hath a great interest in that rest and easiness we enjoy when asleep.

2. Because sleep is inconsistent with the sense of pain, therefore during rest, those nerves which convey that motion to the brain, which excites in the soul a sense of pain, are obstructed; this I myself have had frequent experience of since I have been troubled with sores on my legs; upon sudden awaking finding myself, at perfect ease, and void of all sense of pain for a minute's time or more, the pain then by degrees returning; which I could attribute to nothing but the dissipating that vapour, or whatever else it were, which obstructed the

nerves, and giving the dolorifick motion free passage again.

Upon second thoughts, and reading what Dr. Lister and Dr. Jones have written concerning this subject, I rather incline to believe, that the motion causing a sense of pain, is conveyed to the brain by the nerves themselves in tension, as we see in cords, any the least touch at one end, passes speedily to the other when they are stretched, which it doth not when they are relaxed, and not by the spirits passing thro' them; and on the other side, the insensibleness of pain proceeds rather from the relaxation of the nerves than their obstruction; but yet this tension of the nerves and muscles is owing to the spirits flowing down into them and distending them.

VI. From the constancy that is observed in the number, figure, place, and make of all the principal parts, and from the variety in the less, man is always mending and altering his works, but nature observes the same tenor, because her works are so perfect, that there is no place for amendments, nothing that can be reprehended; the most sagacious men in so many ages have not been able to find any flaw in these divinely contrived and formed machines, *no blot or error in this great volume of the world, as if any thing had been an imperfect essay, at the first* (to use the bishop of Chester's words) nothing that can be altered for the better, nothing but if it were altered would be marred; this could not have been, had man's body been the work of chance, and not council and providence: Why should there be constantly the same parts? why should they retain constantly the same places? why should they be endued with the same shape and figure? Nothing so contrary as constancy and chance. Should I see a man throw the same number a thousand times together upon but three dice, could you persuade me that this were

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accidental, and that there was no necessary cause of it? How much more incredible then is it, that constancy in such a variety, such a multiplicity of parts, should be the result of chance? Neither yet can these works be the effects of necessity or fate, for then there would be the same constancy observed in the smaller as well as the larger parts and vessels; whereas there we see that nature doth *ludere*, as it were sport itself, the minute ramifications of all the vessels, veins, arteries, and nerves, infinitely varying in individuals of the same species, so that they are not in any two alike.

VII. The great wisdom of the divine Creator appears, in that there is pleasure annexed to those actions that are necessary for the support and preservation of the *Individuum*, and the continuation and propagation of the *Species*; and not only so but pain to the neglect or forbearance of them. For the support of the person, it hath annexed pleasure to eating and drinking, which else, out of laziness or multiplicity of business, a man would be apt to neglect, or sometimes forget; indeed to be obliged to chew and swallow meat daily for two hours space, and to find no relish or pleasure in it, would be one of the most burdensome and ungrateful tasks of a man's whole life; but because this action is absolutely necessary, for abundant security nature hath inserted in us a painful sense of hunger, to put us in mind of it; and to reward our performance hath adjoined pleasure to it: and as for the continuation of kind, I need not tell you that the enjoyments which attend those actions are the highest gratifications of sense.

VIII. The wonderful art and providence of the contriver and former of our bodies, appears in the multitude of intentions he must have in the formation of the several parts, or the qualifications they require to fit them for their several uses.



\* Bishop of  
Chester's Nat.  
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uses. \* *Galen* in his book *de Formatione Fœtus*, takes notice, "That there are in a human body above six-hundred several muscles, and there are at least ten several intentions or due qualifications to be observed in each of these; proper figure, just magnitude, right disposition of its several ends, upper and lower, position of the whole, the insertion of its proper nerves, veins, and arteries, which are each of them to be duly placed: so that about the muscles alone no less than six thousand several ends or aims are to be attended to. The bones are reckoned to be 284. The distinct scopes or intentions in each of these are above 40; in all about 100,000. And thus it is in some proportion with all the other parts, the *Skin, Ligaments, Glandules, Humours*: But more especially with the several members of the body, which do, in regard of the great variety and multitude of those several intentions required to them, very much exceeding the *Homogeneous* parts; and the failing in any one of those would cause irregularity in the body, and in many of them such as would be very notorious." Now to imagine that such a machine, composed of so many parts, to the right form, order and motion whereof, such an infinite number of intentions are required, could be made without the contrivance of some wise agent, must needs be irrational in the highest degree.

This wonderful mechanism of human bodies next to viewing the life, may be seen at large in the excellent figures of *Spigelius* and *Bidloo*, their situation, order, connexion, and manner of separating them, in *Lyserus* his *Cult. Anatom.* The almost infinite ramifications and inosculation of all the several sorts of vessels, the structures of the glands, and other organs, may easily be detected

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rected by glasses, and traced by blowing in of air and drying them, or by injecting thro' peculiar syringes melted wax or quicksilver, the operations whereof may be learned out of *Swammerdam*, *Caspar Bortholine*, and *Antonio Nuck*.

IX. Another argument of wisdom and design in contrivance of the body of man and other animals, is the fitting of some parts to divers offices and uses, whereby nature doth (as the Proverb is) *Una fidelia duos parietes dealbare*, stop two gaps with one bush; so (for instance) the *Tongue* serves not only for tasting, but also to assist the mastication of the meat and deglutition, it by turning about, and managing it in the mouth, to gather up the food, in man by licking; and the dog and cat-kind by lapping; in the kine by plucking up the grass; particularly in man it is of admirable use for the formation of words and speaking.

The *Diaphragm*, and muscles of the *Abdomen*, or lower belly, are of use not only for respiration, but also for compressing the intestines, and forcing the chyle into the lacteal veins, and likewise out of the said veins into the *thoracick* channel; and here (to note that by the way) appears the use of a common *Receptacle* of chyle, that by the motion of the muscles of respiration it being pressed upon, the chyle might with more facility be impelled into the fore-mentioned duct; besides, this action of respiration and motion of the said *Diaphragm* and muscles, may serve also for the comminution and concoction of the meat in the stomach (as some, not without reason, think) by their constant agitation and motion upwards and downwards, resembling the pounding or braying of materials in a mortar.

And to instance in no more, the muscular contraction and pulse of the heart serves not only for the circulation of the blood, but also for the more perfect mixture of its parts, preserving its due

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crasis and fluidity, and incorporating the chyle and other juices it receives, with it.

X. The wisdom and goodness too of the divine former of our bodies, appears in the nourishment of them; for that food which is of wholesome juice, and proper to nourish and preserve them in a healthful state, is both pleasant to the taste and grateful and agreeable to the stomach and continues to be so till our hunger and thirst be well appeased, and then begins to be less pleasant, and at last even nauseous and loathsome. *The full stomach loaths the honey-comb.*

On the other side, that which is unwholesome and unfit for nourishment, or destructive of health is also unpleasant to the taste and ungrateful and disagreeable to the stomach, and that more or less according as it is more or less improper or noxious; and though there be some sorts of food less pleasant to the taste, which by use may be rendered grateful, yet to persons that are in health, and in no necessity of using such viands, I think it were better to abstain from them, and follow nature, in eating such things as are agreeable to their palate and stomach; for such unpleasant diet must needs alter the temper of the body before it can become acceptable, and doubtless for the worse.

I might add hereto, that even pain, which is the most grievous and afflictive thing that we are sensible of, is of great use to us. God hath annexed a sense of pain to all diseases and harms of the body, inward and outward (and there is no pain but proceeds from some harm or disease) to be an effectual spur to excite and quicken us to seek for speedy help or remedy; and hath so ordered it that as the disease heals, so the pain abates. Neither doth pain provoke us only to seek ease and relief when we labour under it, but also makes us careful to avoid for the future all such things as are productive of it; that is, such things as are hurtful

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to our bodies, and destructive of the health and well-being of them, which also are for the most part prohibited by God, and so sinful and injurious to our souls. So we see what care the divine providence hath taken, and what effectual means it hath used for the healing of our diseases, and the maintenance and preservation of our health. This is the true reason of our pain; howbeit I will not deny but that God doth sometimes himself immediately inflict diseases, even upon his own children, for many good considerations, which I shall not here enumerate; neither shall I mention the uses that parents and masters make of it, for the correcting their children and servants; or magistrates, for the punishing of malefactors, they being beyond my scope; only I cannot but take notice, that it is a *πολύχρηστον*, a thing of manifold uses, and necessary for the government both of commonwealths and families.

XI. Some fetch an argument of providence from the variety of lineaments in the faces of men, which is such, that there are not two faces in the world absolutely alike; which is somewhat strange, since all the parts are *in Specie* the same. Were nature a blind architect, I see not but the faces of some men might be as like as eggs laid by the same hen, or bullets cast in the same mould, or drops of water out of the same bucket. This particular I find taken notice of by *Pliny* in his seventh book, *cap. 1.* in these words: *Jam in facie vultuque nostro, cum sint decem aut paullo plura membra, nullas duas in tot millibus hominum indiscretas effigies existere, quod Ars nulla in paucis numero præstet affectando.* To which among other things he thus prefaces: *Naturæ vero rerum vis atque majestas in omnibus momentis fide caret.*

Tho' this at first may seem to be a matter of small moment, yet, if duly considered, it will appear

appear to be of mighty importance in all human affairs; for should there be an indiscernible similitude between divers men, what confusion and disturbance would necessarily follow? What uncertainty in all sales and conveyances, in all bargains and contracts? What frauds and cheats and suborning of witnesses? What a subversion of all trade and commerce? What hazard in all judicial proceedings, in all assaults and batteries, in all murders and assassinations? In thefts and robberies, what security would there be to malefactors? who could swear that such and such were the persons that committed the facts, tho' they saw them never so clearly? Many other inconveniences might be instanced in; so that we see this is no contemptible argument of the wisdom and goodness of God.

Neither is the difference of voices less considerable, for the distinguishing of sexes and particular persons, and individuals of all animals, that of faces; as Dr. Cockburn makes out, *Essay*, &c. Part II. Page 68. &c. Nay, in some cases more for hereby persons in the dark and those that are blind may know and distinguish one another which is of great importance to them, for otherwise they might be most grossly cheated and abused.

Farther we may add out of the same author p. 71. "And to no other cause [than the will of providence of God] can be referred the no less strange diversity of hand writings. Common experience shews, that though hundreds and thousands, were taught by one master, and one and the same form of writing, yet they should all write differently: Whether men write *Court* or *Roman* hand, or any other, there is something peculiar in every one's writing which distinguisheth it. Some indeed can counterfeit another's character and subscription, but the instances are rare, nor is it done without

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all human affairs, pains and trouble; nay, the most expert and skilful cannot write much so exactly like as that it cannot be known whether it be genuine or counterfeit; and if the providence of God did not so order it, what cheats and forgeries too would be daily committed, which would not only justle private men out of their rights, but also unhinge states and governments, and turn all into confusion? The diversity of hand-writings is of mighty great use to the peace of the world; it prevents frauds, and secures mens property; it obligeth the living and present to honesty and faithfulness; it importeth the mind of the absent, and sheweth the will of the dead, which ought to be sacredly observed: And what is so very useful, is not the effect of any human concert; men did not of themselves agree to it, they are only carried to it by the secret providence of God, who understands and mindeth what is for the good and interest of mankind in general, and of every particular person."

Add farther to all this, that whereas there are several parts peculiar to brutes which are wanting in man; as for example, the seventh, or suspensory muscle of the eye, the nictating membrane, the strong *Aponeuroses* on the sides of the neck, called by some *Packwax*; it is very remarkable that these parts are of eminent and constant use to them, as I shall particularly shew hereafter, but to man would have been altogether useless and superfluous.

I have done with my general observations, I proceed now more accurately and minutely to consider some particular parts or members of the body; and first, the *Head*, because it was to contain a large brain, made of the most capacious figure, as near as could be to a spherical; upon this grows the hair, which tho' it be esteemed an excrement,



ment, is of great use (as I shewed before) to cherish and keep warm the brain, and to quench the force of any stroke, that might otherwise endanger the skull; it serves also to disburden the brain of a great deal of superfluous moisture, wherewith it abounds.

I find it remarked by *Machetti*, a famous anatomist in *Padua*, that the cause of baldness in men is the dryness of the brain, and its shrinking from the *Cranium*, or skull; he having observed that in bald persons, under the bald part there was always a vacuity or empty space between the skull and the brain: And lastly, to name no more, it serves also for a graceful ornament to the face, which our present age is sensible enough of, bestowing so much money upon false hair and perriwigs.

Secondly, Another member which I shall more particularly treat of, is the *Eye*, a part so artificially composed and commodiously situate, as nothing can be contrived better for use, ornament, or security; nothing to advantage added thereto or altered therein. Of the beauty of the eye I shall say little, leaving that to poets and orators; that it is a very pleasant and lovely object to behold, if we consider the figure, colours, and splendor of it, is the least that I can say. The soul, as it is more immediately and strongly moved and affected by this part than any other, so doth it manifest all its passions and perturbations by this. As the eyes are the windows to let in the *Species* of all exterior objects into the dark cells of the brain for the information of the soul, so are they flaming torches to reveal to those abroad how the soul within is moved or affected. These representations made by the impressions of external objects upon the eye are the most clear, lively, and distinct of any others. Now to this use and purpose of informing us what is abroad round about us in this aspectable world, we shall find this structure and mechanism

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nism of the eye, and every part thereof, so well fitted and adapted, as not the least curiosity can be added; for first of all, the humours and tunics are purely transparent, to let in the light and colours unfoiled and unsophisticated by any inward tincture. It is usually said by the *Peripateticks*, that the crystalline humour of the eye (which they ineptly fancied to be the immediate organ of vision, wherein all the species of external objects were terminated) is without all colour, because its office was to discern all colours, or at least to receive the species of several colours and convey them to the common sense. Now if itself had been coloured; it would have transmitted all visible objects tintured with the same colour; as we see whatever is beheld thro' a coloured glass, appears of the same colour with the glass; and to those that have the jaundice, or the like suffusion of eyes, objects appear of that same colour wherewith their eyes are infected; this, they say, is in a great measure true, altho' they are much mistaken about the organ and manner of vision, and the uses of the humours and membranes of the eye. Two reasons therefore may be assigned why all the membranes and humours of the eye are perfectly pellucid, and void of colour: *First*, For the clearness, *Secondly*, For the distinctness of vision.

*First*, The clearness; for had the tunics and humours of the eye, all, or any of them, been colorate, many of the rays proceeding from the visible object would have been stopt and suffocated before they could come to the bottom of the eye, where the formal organ of vision is situate: for it is a most certain rule, how much any body hath of colour, so much hath it of opacity; and so much the more unfit it is to transmit the species.

*Secondly*, For the distinctness of vision: For, as I said before, and the *Peripateticks* observe well,

were the humours of the eye tinged with any colour, they would refund that colour upon the object, and so it would not be represented to the soul as in itself it is; so we see that thro' a coloured glass things appear as well more dim and obscure as tinged with the colour thereof.

*Thirdly*, The parts of the eye are made convex, and especially the crystalline humour, which is of a lenticular figure, convex on both sides, that by the refractions there made, there might be a direction of many rays coming from one point in the object, viz. as many as the pupil can receive, to one point answerable in the bottom of the eye, without which the sense would be very obscure, and also confused. There would be as much difference in the clearness and distinction of vision, were the outward surface of the *Tunica Cornea* plain, and the crystalline humour removed, as between the picture received on white paper in a dark room thro' an open or empty hole, and the same received through a hole furnished with an exactly polished lenticular crystal; which, how great it is, any one that hath but seen this experiment made, knows well enough; indeed this experiment doth very much explain the manner of vision, the hole answering to the pupil of the eye, the crystalline humour to the lenticular glass, the dark room to the cavity containing the vitreous humour, and the white paper to the *Tunica Retina*.

*Fourthly*, The uveous coat, or *Iris* of the eye, hath a musculous power, and can dilate and contract that round hole in it called the pupil, or sight of the eye; it contracts it, for the excluding superfluous light, and preserving the eye from being injured by too vehement and lucid an object, and again dilates it, for the apprehending objects more remote, or placed in a fainter light; *tam miro artificio* (saith Scheiner) *quam munifica*

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*naturæ largitate.* If any one desires to make experiment of these particulars, he may, following *Scheiner* and *Des Cartes* their direction, take a child, and setting a candle before him, bid him look upon it, and he shall observe his pupil contract itself very much to exclude the light, with the brightness whereof it would otherwise be dazzled and offended; as we are, when after we have been some time in the dark, a bright light is suddenly brought in and set before us, till the pupils of our eyes have gradually contracted themselves; let the candle be withdrawn or removed aside, he shall observe the child's pupil by degrees to dilate itself; or let them take a bead, or the like object, and holding it near the eye, command the child to look at it, the pupil will contract much when the object is near; but let it be withdrawn to a greater distance in the same light, and he shall observe the pupil to be much enlarg'd.

*Fifthly,* The uveous coat, and also the inside of the *Choroides* are blacken'd, like the walls of a tennis-court, that the rays may be there suffocated and suppressed, and not reflected backwards, to confound the sight; and if any be by the retiform coat reflected, they are soon choaked in the black inside of the *Uvea*; whereas were they reflected to and fro, there could be no distinct vision; as we see the light admitted into the dark room we even now speak of, obliterates the *Species* which before were seen upon the white cloth or paper.

*Sixthly,* Because the rays from a nearer and from a more remote object do not meet just in the same distance behind the crystalline humour (as may easily be observed in lenticular glass, where the point or concourse of the rays from a nearer object is at a greater distance behind the glass, and from a farther at a lesser) therefore the *ciliary Processes*, or rather the ligaments observed in the

inside of the sclerotick tunicles of the eye by late ingenious anatomist, do serve instead of muscle, by their contraction to alter the figure of the eye, and make it broader, and consequently draw the *Retina* nearer to the crystalline humour, and by their relaxation suffer it to return to its natural distance, according to the exigency of the object, in respect of distance or propinquity; and besides, possibly the ciliary processes may, by their constriction or relaxation, render the crystalline itself more gibbose or plain, and with the help of the muscles a little alter the figure of the whole eye for the same reason. To what I have said might be added, that the *retiform* tunicle is whitish, for the better and more true reception of the *Species* of things; that there being a distance necessarily required for the collection of the rays received by the pupil, viz. those that proceed from one point of the object to one point again in the bottom of the eye, the *Retina* must needs be set at a distance from the crystalline humour; and therefore nature hath provided a large room, and filled it with the pellucid vitreous humour, most fit for that purpose.

I must not omit a notable observation concerning the place of the insertion of the optick nerve into the bulb of the eye, and the reason of it; which I owe to that learned mathematician *Peter Herigon*: *Nervus opticus* (saith he in his *Optica*) *ad latus ponitur, ne pars imaginis in ejus foramen incidens pictura careat*: The optick nerve is not situate directly behind the eye, but on one side, lest that part of the image that falls upon the hole of the optick nerve should want its picture. This I do not conceive to be the true reason of this situation; for even now as it is situate, that part of the object whose rays fall upon the centre, or hole of the optick nerve, wants its picture, as we find by experience, that part not being seen by us, tho'

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we heed it not; but the reason is, because if the optick *Axis* should fall upon this centre (as it would do were the nerve seated just behind the eye) this great inconvenience would follow, that the middle point of every object we viewed would be invisible, or there would be a dark spot appear in the midst of it; thus we see the admirable wisdom of nature in thus placing the optick nerve in respect of the eye, which he that did not consider or understand, would be apt to think more inconveniently situate for vision than if it had been right behind.

Another thing also concerning vision is most remarkable, that tho' there be a decussation of the rays in the pupil of the eye, and so the image of the object in the *Retina* or bottom of the eye be inverted, yet doth not the object appear inverted, but in its right or natural posture; the reason whereof is, because the visual rays coming in straight lines by those points of the sensory or *Retina* which they touch, affect the common sense or soul, according to their direction; that is, signify to it, that those several parts of the object from whence they proceed lie in straight lines (point for point) drawn thro' the pupil to the several points of the sensory, where they terminate, and which they press upon; whereupon the soul must needs conceive the object, not in an inverted but a right posture; and that the nerves are naturally made, not only to inform the soul of external objects which press upon them, but also of the situation of such objects, is clear; because if the eyes be distorted, the object, will we will we, will appear double; so if the fore and middle fingers be crossed, and a round body put between them, and moved, it will seem to be two; the reason is, because in that posture of the fingers the body touches the outsides of them, which in their natural site are distant one from another, and their nerves made to signify to the soul bodies

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separate, and distant in like manner, two fingers lying between them; and tho' our reason, by the help of our sight, corrects this error, yet cannot we but fancy it to be so.

Neither is the *aqueous Humour*, as some may supinely imagine, altogether uselefs or unprofitable as to vision, because by its help the *Uvea Tunica* is sustained, which else would fall flat upon the crystalline humour; and fluid it must be to give way to the contraction and dilatation of the uveous; and because the uttermost coat of the eye might chance to be wounded or pricked, and this humour, being fluid, let out, therefore nature hath made provision speedily to repair it again in such a case, by the help of certain water-pipes, or lymphæducts, inserted into the bulb of the eye, proceeding from glandules designed by nature to separate this water from the blood for that use. *Antonius Nuck* affirms, that if the eye of an animal be pricked, and the aqueous humour squeezed out, in ten hours space the said humour and sight shall be restored to the eye, if at least the creature be kept in a dark place. And that he did publicly demonstrate the same in the anatomical theatre at *Leyden*, in a dog, out of whose eye, being wounded, the aqueous humour did so copiously flow, that the membranes appeared flaccid, and yet in six hours space the bulb of the eye was again replete with its humour, and that without the application of any medicines. *Antonius Nuck de ductu novo salivari, &c.*

Moreover, it is remarkable, that the *Cornea Tunica* [horny or pellucid coat of the eye] doth not lie in the same *Superficies* with the white of the eye, but riseth up, as it were a hillock, above its convexity, and is of an *hyperbolic* or *parabolic* figure; so that tho' the eye seems to be perfectly round, in reality it is not so, but the *Iris* thereof is protuberant above the white; and the

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reason is, because that if the *Cornea Tunica*, or crystalline humour, had been concentrical to the *Sclerodes*, the eye could not have admitted a whole hemisphere at one view, & *sic animalis incolumitati in multis rebus minus cautum esset*, as Scheiner well observes. In many things there had not been sufficient caution or care taken for the animal's safety.

And now (that I may use the words of a late author of our own) the eye is already so perfect, that I believe the reason of a man would easily have rested here, and admired at his own contrivance. For he being able to move his whole body upward and downward, and on every side, might have unawares thought himself sufficiently well provided for; but nature hath added muscles also to the eyes that no perfection might be wanting; for we have often occasion to move our eyes, our head being unmoved, as in reading and viewing more particularly an object set before us, by transferring the *Axis* of our eyes all over it; and that this may be done with the more ease and accuracy, she hath furnished this organ with no less than six muscles, to move it upward, downward, to the right and left, obliquely, and round about.

I shall now consider what provision is made for the defence and security of this most excellent and useful part.

*First*, The eyes are sunk in a convenient valley, *latent utiliter*, and are encompassed round with eminent parts, as with a rampart, & *excelsis undique partibus sepiuntur*, \* Cic.

so are defended from the strokes of any flat or broad bodies. Above stand the eye-brows, to keep off any thing from running down upon them, as drops of sweat from the forehead, or dust, or the like. *Superiora superciliis obducta sudorem a capite & fronte defluentem repellunt*. Cic. Then follow the *eye-lids*, which fence

Dr. More's  
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\* De Natura  
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fence them from any sudden and lesser stripes; these also round the edges are fortified with stiff bristles as it were palisadoes, against the incursions of importunate animals, serving partly as a fan to strike away flies, or gnats, or any other troublesome insects; and partly to keep off superfluous light. *Munitæque sunt palpebræ tanquam vallo pilorum quibus & apertis oculis siquid insideret repellere tur.* Idem, ibid. And because it was necessary that man and other animals should sleep, which could not be so well done if the light came in by the windows of the eyes, therefore hath nature provided these curtains to be then drawn to keep it out. And because the outward coat of the eye ought to be pellucid, to transmit the light, which if the eyes should always stand open, would be apt to grow dry and shrink, and lose their Diaphaneity, therefore are the eye-lids so contriv'd as often to wink, that so they may as it were glaze and varnish them over with the moisture they contain, there being glandules on purpose to separate an humour for that use, and withal wipe off whatever dust or filth may stick to them; and this, lest they should hinder the sight, they do with the greatest celerity. *Cicero* hath taken notice, that they are made very soft, lest they should hurt the sight. *Mollissime tactu ne læderent aciem, aptissime facti & ad claudendas pupillas ne quid insideret, & ad aperiendas, idque providit ut identidem fieri posset maxima cum celeritate.*

Secondly, If we consider the bulb or ball of the eye, the exterior membrane or coat thereof is made thick, tough and strong, that it is a very hard matter to make a rupture in it, and besides so slippery, that it eludes the force of any stroke to which also its globular figure gives it a very great advantage.

Lastly, Because for the guidance and direction of the body in walking, and any exercise, it is

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To all this I might add the convenience of the situation of the eye in respect of its proximity to the brain, the seat of apprehension and common sense; whereas had it been farther removed, the *optick nerves* had been liable to many more dangers and inconveniences than now they are.

Seeing then the eye is composed of so great variety of parts, all conspiring to the use of vision, whereof some are absolutely necessary, others very useful and convenient, none idle or superfluous; and, which is remarkable, many of them of a different figure and consistency from any others in the body besides, as being transparent, which it was absolutely necessary they should be, to transmit the rays of light; who can but believe that this organ was designed and made purposely for the use for which it serves?

Neither is it to be esteemed any defect or imperfection in the eyes of man, that they want the seventh muscle, or the nictating membrane, which the eyes of many other animals are furnished withal; for tho' they be very useful, and in a manner necessary to them, considering their manner of living, yet they are not so to man. To such beasts as feed upon grass, and other herbs, and therefore are forc'd to hold their eyes long in a hanging posture, and to look downwards for the chusing and gathering of their food, the seventh or suspensory muscle is very useful, to enable them to

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do so without much pain or weariness; yet to man, who doth not, nor hath any occasion, indeed cannot hold his head or look long downwards, it would be useless and superfluous. As for the nictating membrane, or *Periophthalmium*, which all birds, and I think most quadrupeds are furnished with, I have been long in doubt what the use of it might be, and have sometimes thought it was for the more abundant defence and security of the eye; but then I was puzzled to give any tolerable account why nature should be more solicitous for the preservation of the eyes of brutes than men, and in this respect also to be a step-mother to the most noble creature.

\* Boyle of *final Causes*, p. 53, 54.

But the honourable \* Author formerly mentioned gives a probable account why frogs and birds are furnished with such a membrane. Frogs, because being amphibious animals, designed to pass their lives in watery places, which for the most part abound with sedges, and other plants endowed with sharp edges or points; and the progressive motion of this animal being to be made not by walking, but by leaping, if his eyes were not provided of such a sheath, he must either shut them, and so leap blindly, and by consequence dangerously, or by leaping them open run a venture to have the *Cornea* cut, pricked, or otherwise offended by the edges or points of the plants, or what may fall from them upon the animal's eye; whereas this membrane (being something transparent as well as strong) is like a kind of spectacle, that covers the eye without taking away the sight. Birds are likewise furnished with it, because being destinated to fly among the branches of trees and bushes, their prickles, twigs, leaves, or other parts, would be apt otherwise to wound or offend their eyes. But yet still we are to seek why it is given

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 to other quadrupeds, whose eyes are in no such danger:

*Thirdly*, The ear, another organ of sense, how admirable it is contrived for the receiving and conveying of sounds. *First*, There is the outward ear, or *Auricula*, made hollow, and contracted by degrees, to draw the sound inward, to take in as much as may be of it, as we use a funnel to pour liquor into any vessel; and therefore if the *Auricula* be cut clear off, the hearing is much impaired, and almost quite marred, as hath been by experience found. From the *Auricula* is extended a small, long, round hole inward into the head, to intend the motion, and so augment the force of the sound, as we see in a shooting-trunk, the longer it is to a certain limit, the swifter and more forcibly the air passes in it and drives the pellet. At the end of this hole is a membrane fastened to a round boney limb, and stretched like the head of a drum, and therefore by anatomists called also *Tympanum*, to receive the impulse of the sound, and to vibrate or quaver according to its reciprocal motions or vibrations; the small ear-bones being at the end fastned to the *Tympanum*, and furnished with a muscle, serve for the tension of that membrane, or the relaxation of it, according to the exigency of the animal, it being stretched to the utmost when it would hearken diligently to a lower or more distant sound. Behind the drum are several vaults and anfractuons cavities in the ear-bone, filled only with what naturalists call the implanted air, so to intend the least sound imaginable that the sense might be affected with it; as we see in subterraneous caves and vaults how the sound is redoubled, and what a great report it makes how- ever moderate it be; and because it was for the behoof of the animal, that upon any sudden accident it might be awakened out of its sleep, therefore were there no shuts or stopples made for the



ears, that so any loud or sharp noise might awake it, as also a soft and gentle voice of murmure provoke it to sleep. Now the ears, for the benefit and conveniences of the *animal*, being always to stand open, because there was some danger that insects might creep in thereat, and eating their way thro' the *Tympanum* harbour in the cavities behind it, therefore hath nature loricated or plaistered over the sides of the forementioned hole with ear-wax, to stop or entangle any insects that should attempt to creep in there. But I must confess myself not sufficiently to understand the nature of sounds, to give a full and satisfactory account of the structure and uses of all the parts of the ear; they who have a mind to search into the curious anatomy and use of this part, may consult monsieur *du Verney*.

Fourthly, The next part I shall take notice of shall be the *teeth*, concerning which I find several observations in the honourable Mr. *Boyle's* treatise of *final Causes*, which I shall briefly recapitulate and add one or two more.

I. That the teeth alone, among the bones, continue to grow in length during a man's whole life as appears by the unsightly length of one tooth when its opposite happens to fall or be pull'd out, which was most providentially designed to repair the waste that is daily made of them by the frequent attrition in mastication. Here, by the by I might advise men to be careful how they attempt to cure this blemish, by filing or cutting off the head of such an overgrown tooth, lest that befall them which happened to a certain nun in *Padua* who upon cutting off a tooth in that manner was presently convulsed, and fell into an epilepsy as *Bartholine*, in his *Anatomy*, reports.

II. That that part of the teeth which is extended above the gums is naked, and not invested with

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that sensible membrane called *Perioſtium*, where-  
with the other bones are covered.

III. That the teeth are of a cloſer and harder  
ſubſtance than the reſt of the bones, for the more  
eaſy breaking and comminution of the more ſolid  
aliments, and that they might be more durable,  
and not ſo ſoon worn down by grinding the food.

IV. That for the nourishing and cheriſhing  
theſe ſo neceſſary bones, the all-wiſe author of  
things has admirably contrived an unſeen cavity in  
each ſide of the jaw-bone, in which greater chan-  
nel are lodged an artery, a vein, and a nerve,  
which thro' leſſer cavities, as it were thro' gutters,  
ſend their twigs to each particular tooth.

V. Becauſe infants were for a conſiderable time  
to feed upon milk, which needs no chewing, and  
leſt teeth ſhould hurt the tender nipples of the  
nurse, nature hath deferred the production of them  
for many months in a human *Fœtus*; whereas  
thoſe of divers other animals, which are reduced  
to ſeek betimes food that needs maſtication, are  
born with them.

VI. The different figure and ſhape of the teeth is  
remarkable. That the fore-teeth ſhould be formed  
broad and with a thin and ſharp edge, like chiſſels,  
to cut off and take away a morſel from any ſolid  
food, called therefore *Incifoſes*. The next, one on  
each ſide, ſtronger, and deeper rooted, and more  
pointed, called therefore *Canini*; in *Engliſh*, eye-  
teeth, to tear the more tough and reſiſting ſort of  
aliments. The reſt, called jaw-teeth, or grinders, in  
*Latin*, *Molares*, are made flat and broad a-top,  
and withal ſomewhat uneven and rugged, that by  
their knobs and little cavities they may the better  
retain, grind, and commix the Aliments.

VII. Becauſe the operations to be performed by  
the teeth oftentimes require a conſiderable firm-  
neſs and ſtrength, partly in the teeth themſelves,  
partly in the instruments which move the lower

jaw, which alone is moveable, nature hath provided this with strong muscles, to make it bear forcibly against the upper jaw; and thus not only placed each tooth in a distinct cavity of the jaw-bone, as it were in a close, strong, and deep socket, but has furnished the several sorts of teeth with holdfasts suitable to the stress, that by reason of their different offices they are to be put to; and therefore, whereas the *cutters* and *eye-teeth* have usually but one root (which in these last named is wont to be very long) the *grinders*, that are employed to crack nuts, stones of fruit, bones, or other hard bodies, are furnished with three roots, and in the upper jaw often with four, because these are pendulous, and the substance of the jaw somewhat softer.

VIII. The situation of the teeth is most convenient, *viz.* the *Molares* or *Grinders* behind, nearest the centre of motion, because there is a greater strength or force required to chew the meat than to bite a piece; and the *cutters* before, that they may be ready to cut off a morsel from any solid food, to be transmitted to the *Grinders*.

IX. It is remarkable that the jaw in men, and such animals as are furnished with grinders, hath an oblique and transverse motion, which is necessary for chewing and comminution of the meat, which it is observed not to have in those animals that want the *Molares*.

Now if (as *Galen* saith) he that shall marshal a company but of thirty-two men in due order, is commended for a skilful and industrious person, shall we not admire nature, which hath so skilfully ranked and disposed this quire of our teeth?

*Fifthly*, The *tongue* is no less admirable for the contexture and manifold uses of it. *First*, It is the organ of tasting; for being of a spongy substance, the small particles of our meat and drink being mingled with the *Saliva*, easily insinuate them-

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themselves into the pores of it, and so do either gratefully affect it, or harshly grate upon it, according as they are figured and moved; and hereby we discern what is convenient or inconvenient for our nourishment. It helps us likewise in the chewing and swallowing of our meat. And *lastly*, It is the main instrument of speaking, a quality so peculiar to man, that no beast could ever attain to it. And although birds have been taught to form some words, yet they have been but a few, and those learned with great difficulty; but what is the chief, the birds understand not the meaning of them, nor use them as signs of things, or their own conceptions of them, tho' they may use them as expressions of their passions; as Parrots having been used to be fed at the prolation of certain words, may afterwards, when they are hungry, pronounce the same. For this *Des Cartes* makes his main argument to prove that brutes have no cogitation, because the highest of them could never be brought to signify their thoughts or conceptions by any artificial signs, either words or gestures (which, if they had any, they would in all likelihood be forward enough to do;) whereas all men, both fools and mutes, make use of words or other signs to express their thoughts about any subjects that present themselves, which signs also have no reference to any of their passions; whereas the signs that brute animals may be taught to use, are no other than such as are the motions of some of their passions, fear, hope, joy, &c. Hence some of the *Jewish* rabbins did

not so absurdly define a man \* *Animal loquens*, a speaking creature.

Having had occasion just now to mention the *Saliva*, or spittle, I am put in mind of the eminent use of this humour, which is commonly taken for an excrement. Because a great part of our food is dry, therefore nature hath

provided several grandules to separate this juice from the blood, and no less than four pair of channels to convey it into the mouth, which are of late invention, and called by anatomists *Ductus Salivales*, thro' which the *Saliva* distilling continually, serves well to macerate and temper our meat, and make it fit to be chewed and swallowed. If a copious moisture did not by these conduits pipes incessantly flow down into the mouths of *horses* and *kine*, how were it possible they should for a long time together grind and swallow such dry meat as hay and straw? Moreover, it is useful not only in the mouth, but the stomach too, to promote concoction, as we have already noted.

*Sixthly*, To the mouth succeeds the *windpipe*, no less wonderful in its conformation; for because continual respiration is necessary for the support of our lives, it is made with annular cartilages, to keep it constantly open, and that the sides of it may not flag and fall together; and lest, when we swallow, our meat or drink should fall in there and obstruct it, it hath a strong shut or valve, called *Epiglottis*, to cover it close and stop it when we swallow: For the more convenient bending of our necks, it is not made of one entire continued cartilage, but of many annular ones, joined together by strong membranes, which membranes are muscular, compounded of straight and circular fibres, for the more effectual contraction of the windpipe in any strong or violent expiration or coughing; and lest the asperity or hardness of their cartilages should hurt the *Oesophagus* or gullet, which is tender, and of a skinny substance, or hinder the swallowing of our meat, therefore these annular gristles are not made round, or entire circles; but where the gullet touches the windpipe, there to fill up the circle, is only a soft membrane, which may easily give way to the dilation of the gullet; and to demon-

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strate that this was designedly done for this end and use, so soon as the windpipe enters the lungs, its cartilages are no longer deficient, but perfect circles or rings, because there was no necessity they should be so, but it was more convenient they should be entire. *Lastly*, For the various modulation of the voice, the upper end of the windpipe is endued with several cartilages and muscles, to contract or dilate it, as we would have our voice flat or sharp; and moreover, the whole is continually moistened with a glutinous frameur, issuing out of the small glandules that are upon its inner coat to fence it against the sharp air received in, or breath forced out; yet is it of quick and tender sense, that it may be easily provoked to cast out by coughing whatever may fall into it from without, or be discharged into it from within.

It is also very remakable which *Caspar Bartholine* hath observed in the gullet, that where it perforateth the midriff, the carneous fibres of that muscular part are inflected and arcuate, as it were a *spincter* embracing and closing it fast, by a great providence of nature, lest in the perpetual motion of the said midriff the upper orifice of the stomach should gape, and cast out the victuals as fast as it received it.

*Seventhly*, The heart, which hath been always esteemed, and really is one of the principal parts of the body, the *primum vivens*, & *ultimum moriens*, the first part that quickens, and the last that dies, by its incessant motion distributing the blood, the vehicle of life, and with it the vital heat and spirits, throughout the whole body, whereby it doth continually irrigate, nourish, and keep hot, and supple all the members. Is it not admirable that from this fountain of life and heat there should be channels and conduit-pipes to every, even the least and most remote part of the body? Just as if from one water-house there should be pipes



pipes conveying water to every house in a town and to every room in each house; or from one fountain in a garden there should be little channels or dikes cut to every bed, and every plant growing therein, as we have seen more than once done beyond the seas. I confess the heart seems not to be designed to so noble an use as is generally believed, that is, to be the fountain or conservatory of the vital flame, and to inspire the blood therewith (for the lungs serve rather for the accension, or maintaining that flame, the blood receiving there from the air those particles which are one part of the *Pabulum*, or fuel thereof, and so impregnated, running back to the heart) but to serve as a machine to receive the blood from the veins, and to force it out by the arteries thro' the whole body, as a syringe doth any liquor, though not by the same artifice; and yet this is no ignoble use, the continuance of the circulation of the blood being indispensably necessary for the quickning and enlivening of all the members of the body, and supplying of matter to the brain, for the preparation of the animal spirits, the instruments of all sense and motion. Now for this use of receiving and pumping out of the blood, the heart is admirably contrived. For, *First*, Being a muscular part, the sides of it are composed of two orders of fibres, running circularly or spirally from base to tip, contrarily one to the other, and so being drawn or contracted contrary ways, do violently constringe and straiten the ventricles, and strongly force out the blood, as we have formerly intimated; then the vessels we call *Arteries*, which carry from the heart to the several parts, have valves, which open outwards, like trap-doors, and give the blood a free passage out of the heart, but will not suffer it to return back again thither; and the *Veins* which bring it back from the several members to the heart, have valves or trap-doors, which

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in a town open inwards, so as to give way unto the blood to  
 r from one run into the heart, but prevent it from running  
 little chan- back again that way; besides, the arteries consist  
 every plane of a quadruple coat, the third of which is made up  
 e than once of annular or orbicular carneous fibres to a good  
 heart seems thickness, and is of a muscular nature, after every  
 is generally pulse of the heart, serving to contract the vessel  
 or conserva- successively with incredible celerity, so by a kind  
 e the blood of peristaltick motion impelling the blood onwards  
 for the ac- to the capillary extremities and thro' the muscles  
 e blood re- with great force and swiftness; so the pulse of  
 es which are the arteries is not only caused by the pulsation of  
 eof, and so the heart driving the blood thro' them in manner  
 heart) but of a wave or flush, as *Des Cartes* and others  
 d from the would have it, but by the coats of the arteries  
 ies thro' the themselves, which the experiments  
 nor, though of a certain \* *Lovain* physician (the  
 s no ignoble first whereof is *Galen's*) do, in my  
 of the blood opinion, make good against him.

\* *Cartes Ep.*  
*V. 1. Ep. 77.*  
*et Sep.*

First, *saith he*, if you slit the artery, and thrust  
 into it a pipe, so big as to fill the cavity of it,  
 and cast a straight ligature upon that part of  
 the artery containing the pipe, and so bind it  
 fast to the pipe; notwithstanding the blood  
 hath free passage thro' the pipe, yet will not  
 the artery beat below the ligature; but do but  
 take off the ligature, it will commence again  
 to beat immediately." But because one might  
 be ready to reply to this experiment, that the rea-  
 son why when bound it did not beat, was because  
 the current of the blood being straitned by the  
 pipe, when beneath the pipe it came to have more  
 liberty, was not sufficient to stretch the coat of  
 the artery, and so cause a pulse, but when the  
 ligature was taken off it might flow between the  
 enclosed tube and the coat of the artery; there-  
 fore he adds another, which clearly evinces that  
 this could not be the reason, but that it is some-  
 thing flowing down the coats of the artery that  
 causes

causes the pulse; that is if you straiten the artery of nature never so much, provided the sides of it do not in the vessel quite meet and stop all passages of the blood, that in the vessel will notwithstanding continue still to beat I shall give below or beyond the coarctation. So we see several " As reported by the physicians, both ancient (as *Galen*) and modern " port the were of opinion that the pulse of the arteries was " again to owing to their coats; tho' the first that I know " their e who observed the third coat of an artery to be " trunks muscular body, composed of annular fibres, was " ries, v Dr. *Willis*. This mention of the peristaltick motion " in displa tion puts me in mind of an ocular demonstration " the re of it in the gullet of kine when they chew " and fo cud, which I have often beheld with pleasure " abund for after they have swallowed one morsel, if you " veloci look stedfastly upon their throat you will soon see " parts, another ascend, and run pretty swiftly all along " tifices the throat up to the mouth, which it could not " as we do, unless it were impelled by the successive contraction " teries or peristaltick motion of the gullet continually following; and it is remarkable that the " Th are no ruminant creatures have a power by the Imperium " and of their wills of directing this peristaltick motion " the b upwards or downwards. I shall add no more concerning " Arter the heart, but that it and the brain perform " nings mutuas operas tradere, enable one another to work " cavit For, First, The brain cannot itself live unless it receives " blood continual supplies of blood from the heart; " it sho but less can it perform its functions, of preparing " The and distributing the animal spirits, nor the heart " in th pulse, unless it receives spirits or something else " diver that descends from the brain by the nerves; for " in h but cut asunder the nerves that go from the " oper brain to the heart, the motion thereof, in man " T perfect and hot creatures, ceaseth immediately " leng Which part began this round is the question. " their

I find in the *Philosophical Transactions*, N<sup>o</sup> 28 some notable observations of the famous anatomist Mr. *William Cowper*, concerning the artifice " and " pen " chan



of nature in regulating the motion of the blood in the veins and arteries, to assist and promote it in the one, and moderate it in the other, which I shall give you in his own words.

"As the *Arteries* (saith he) are known to export the blood, so the *Veins* to carry it back again to the heart; but having already described their extremities, we come now to the large trunks of the *Veins*; and here, as in the *Arteries*, we find the common practise of nature, in disposing the branches of veins to discharge the reflux blood into the next adjacent trunk, and so on to the heart. As the *Arteries* afford abundance of instances of checks given to the velocity of the current of blood thro' several parts, so the veins supply us with as many artifices to assist its regular return to the heart, as well as favour those contrivances in the *Arteries*.

"The *carotid*, *vertebral*, and *splenick Arteries*, are not only variously contorted, but also here and there dilated, to moderate the motion of the blood; so the *Veins* that correspond to those *Arteries* are also variously dilated. The beginnings of the internal *Jugulars* have a bulbous cavity, which are *diverticula* to the reflux blood in the *Sinus's* of the *Dura Mater*, lest it should descend too fast into the *Jugulars*. The like has been taken notice of by Dr. Lower in the *vertebral Sinus's*. The *splenick Vein* has divers cells opening into it near its extremities in human bodies, but in quadrupeds the cells open into the trunks of the splenic veins.

"The *spermatic* veins do more than equal the length of the arteries of the *Testes* in men; their various divisions, and several inosculations, and their valves, are admirably contrived to suspend the weight of the blood, in order to discharge it into the larger trunks of the veins; and

“ and were it not that the reflux blood from the  
 “ *Testes* is a *Pondus* to the influent blood from the  
 “ *Arteries*, and still lessens its current in the *Testes*  
 “ these spermatic veins, like those of other parts  
 “ might have discharged the blood into the next  
 “ adjacent trunk.

“ Who can avoid surprize at the art of na-  
 “ ture, in contriving the veins that bring part of  
 “ the reflux blood from the lower parts of the  
 “ body, when they consider the necessity of pla-  
 “ cing the human heart, as well as that of most  
 “ quadrupeds, so far from the centre of the body  
 “ towards its upper part; it is for that end ne-  
 “ cessary that the large trunks of the veins and  
 “ *Arteries* should not associate each other; for if  
 “ all the blood sent to the lower parts by the de-  
 “ scending trunk of the *Aorta*, should return to  
 “ the heart again by one single trunk (as it is  
 “ sent out from thence) the weight of so much  
 “ blood in the ascending trunk of the *Vena Cava*  
 “ would oppose all the force the heart could give  
 “ it from the arteries, and hinder its ascent;  
 “ for this reason the *Vena Azygos* or *sine Pari* is  
 “ contrived to convey the blood sent to the muscles  
 “ of the back and *Thorax* into the descending  
 “ trunk of the *Vena Cava* above the heart; hence  
 “ it is evident that more blood comes into the  
 “ heart by the descending or upper trunk of the  
 “ *Vena Cava*, than passes out by the ascending  
 “ trunk of the *Aorta*; nor does the quantity  
 “ of blood conveyed to the heart by the superior  
 “ trunk of the *Vena Cava*, seem without some  
 “ other design in nature besides transporting it  
 “ thither, to free the inferior trunk from its  
 “ weight; but perhaps it was necessary so much  
 “ blood should be ready there to join with the  
 “ *Chyle*, for its better mixture, before it reaches  
 “ the right auricle of the heart.” So far Mr.  
 Cowper.

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*Eighthly*, The next part I shall treat of shall be the *Hand*, this ὀργάνον ὀργάνων, or superlative instrument, which serves us for such a multitude of uses, as it is not easy to enumerate; whereto, if we consider the make and structure of it, we shall find it wonderfully adapted. *First*, It is divided into four fingers bending forward, and one opposite to them bending backwards, and of greater strength than any of them singly, which we call the thumb, to join with them severally or united, whereby it is fitted to lay hold of objects of any size or quantity; the least things, as any small single seed, are taken up by the thumb and fore finger, those a little greater by the thumb and two fingers, which also we chiefly employ to manage the needle in sewing and the pen in writing; when we would take up a greater quantity of any thing, we make use of the thumb and all the fingers; sometimes we use one finger only, as in pointing at any thing, picking things out of holes or long and narrow vessels; sometimes all severally at one time, as in stopping the strings when we play upon any musical instruments. *Secondly*, The fingers are strengthened with several bones, jointed together for motion, and furnished with several muscles and tendons, like so many pullies, to bend them circularly forwards, which is most convenient for the firm holding and gripping of any object; which of how great, constant and necessary use it is in pulling or drawing, but especially in taking up and retaining any sort of tool or instrument to work withal in husbandry and all mechanic arts, is so obvious to every man's observation, that I need not spend time to instance in particulars; moreover the several fingers are furnished with several muscles, to extend and open the hand, and to move the right and left; and so this division and motion of the fingers doth not hinder but that the whole hand may be employed



as if it were all of a piece, as we see it is, either expanded, as in striking out, smoothing and folding up clothes, and some mechanick uses; or contracted, as in fighting, kneading of dough, and the like; it is also notable, and indeed wonderful, that the tendons bending the middle joint of the fingers should be perforated, to give passage to the tendons of the muscles which draw the uppermost joints, and all bound down close to the bones with strong fillets, lest they should start up and hinder the hand in its work, standing like so many bow-strings. *Thirdly*, The fingers-ends are strengthened with nails, as we fortify the ends of our staves and forks with iron hoops or ferules; which nails serve not only for defence, but for ornament, and many uses. The skin upon our fingers-ends is thin, and of most exquisite sense, to help us to judge of any thing we handle. If now I should go about to reckon up the several uses of this instrument, time would sooner fail me than matter. By the help of this we do all our works, we build ourselves houses to dwell in, we make ourselves garments to wear, we plow and sow our grounds with corn, dress and cultivate our vineyards, gardens and orchards, gather and lay up our grain and fruits, we prepare and make ready our victuals; spinning, weaving, painting, carving, engraving, and that divinely invented art of writing, whereby we transmit our own thoughts to posterity, and converse with and participate the observations and inventions of them that are long ago dead, all performed by this; this is the only instrument for all arts whatsoever, no improvement to be made of any experimental knowledge without it. Hence (as *Aristotle* saith well) they do amiss that complain that man is worse dealt with by nature than any other creatures; whereas they have some hair, some shells, some wool, some feathers some scales, to defend themselves from the

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injuries of the weather, man alone is born naked and without all covering; whereas they have natural weapons to defend themselves and offend their enemies, some horns, some hoofs, some teeth, some talons, some claws, some spurs and beaks; man hath none of all these, but is weak and feeble, and unarmed sent into the world: Why, a hand, with reason to use it, supplies the uses of all these, that's both a horn and a hoof, and talon and a tush, &c. because it enables us to use weapons of these and other fashions, as swords, and spears, and guns; besides this advantage a man hath of them, that whereas they cannot at pleasure change their coverings, or lay aside their weapons, or make use of others as occasion serves, but must abide Winter and Summer, Night and Day with the same cloathing on their backs, and sleep with their weapons upon them; a man can alter his cloathing according to the exigency of the weather, go warm in Winter and cold in Summer, cover up himself hot in the night, and lay aside his cloaths in the day, and put on or off more or fewer, according as his work and exercise is; and can, as occasion requires, make use of divers sorts of weapons, and choice of such at all turns as are most proper and convenient; whereby we are enabled to subdue and rule over all other creatures, and use for our own behoof those qualities wherein they excel, as the strength of the ox, the valour and swiftness of the horse, the sagacity and vigilancy of the dog, and so make them as it were our own. Had we wanted this member in our bodies we must have lived the life of brutes, without house or shelter, but what the woods and rocks would have afforded, without cloaths or covering, without corn, or wine, or oil, or any other drink but water; without the warmth and comfort, or other uses of fire, and so without any artificial baked, boiled, or roast meats; but

must have scrambled with the wild beasts for crabs, and nuts, and acorns, and such other things as the earth puts forth of her own accord; we had laid open and exposed to injuries, and had been unable to resist or defend ourselves against almost the weakest creature.

The remaining parts I shall but briefly run over.

That the *Back-bone* should be divided into so many vertebres for commodious bending, and not be one intire rigid bone, which being of that length would have been often in danger of snapping asunder; that it should be made tapering, in form of a pillar, the lower vertebres being the broadest and largest, and the superior in order lesser and lesser, for the greater firmness and stability of the trunk of the body; that the several vertebres should be so elegantly and artificially compacted and joined together, that they are as strong and firm as if they were but one bone; that they should be all perforated in the middle, with a large hole for a spinal marrow or pith to pass along, and each particular have a hole on each side to transmit the nerves to the muscles of the body, to convey both sense and motion; that by reason of the fore-mentioned close connexion to the vertebres, it should be so formed as not to admit any great flexure or recess from a right line any angular, but only a moderate circular bending, lest the spinal pith should be compressed, and so the free intercourse or passage of the spirits to and fro be stopt.

One observation relating to the motion of the bones in their articulations I shall here add, that is, the care that is taken and the provision that is made for the easy and expedite motion of them, there being to that purpose a twofold liquor prepared, for the inunction and lubrication of three heads or ends. 1. An oily one, furnished by the marrow. 2. A mucilaginous, supplied by

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certain glandules seated in the articulations, both which together make up the most apt and proper mixture for this use and end that can be invented or thought upon; for not only both the ingredients are of a lubricating nature, but there is this advantage gained from their composition, that they do mutually improve one another; for the mucilage adds to the lubricity of the oil, and the oil preserves the mucilage from inspissation, and contracting the consistency of a gelly. Now this inunction is useful, indeed necessary, for three ends chiefly.

1. For the facilitating of motion. For tho' the ends of the bones are very smooth, yet were they dry they could not with that readiness and ease, nay, not without great difficulty, yield to and obey the plucks and attractions of the motory muscles; as we see clocks and jacks, though the screws and teeth of the wheels and nuts be never so smooth and polished, yet if they be not oiled will hardly move, tho' you clog them with never so much weight; but if you apply but a little oil, they presently whirl about very swiftly with the tenth part of the force.

2. For preserving the ends of the bones from an incallescency, which they, being hard and solid bodies, would necessarily contract from a swift and long continued motion; such as that of running, or mowing, or threshing, or sawing, and the like, if they are immediately touched and rubbed against one another with that force they must needs do, especially in running, the whole weight of the body bearing upon the joints of the thighs and knees. So we see in the wheels of waggons or coaches, the hollows of the naves, by their swift rotations on the ends of the axle-trees, produce a heat, sometimes so intense as to set them on fire; to prevent which they stand in need to be frequently anointed or besmeared with a mixture of grease

and tar, imitating the fore-mentioned natural composition of oil and mucilage. Nay, bodies softer a great deal than metals contract a great heat by attrition, as is evident from those black circular lines we see on boxes, dishes, and other turned vessels of wood, which are the effects of ignition, caused by the pressure of an edged stick upon the vessel turned nimbly in the lathe. And if there had not been a provision in the joints against such a preternatural incalcescence upon their violent motion, this would have made a slothful world, and confined us to leisurely and deliberate movements, when there were the most urgent and hasty occasions to quicken us.

3. For the preventing of attrition, and wearing down the ends of the bones by their motion and rubbing one against another, which is so violent and lasting sometimes, that it is a wonder any union should suffice to secure their heads from wasting and consumption. I have often seen the tops of the teeth (which are of a harder substance than the rest of the bones) worn off by mastication, in persons who have lost most of their grinders, and been compelled constantly to make use of three or four only in chewing, so low, that at last the inward marrow and nerve lay bare, and they could no longer for pain make use of them; so that had there not been this provision made for the anointing the bones, the curious workmanship of nature in adapting them so exactly one to another, as was most fit for the easy performance of all those motions to which they were destined, would not suffice for use; but the stirring part of mankind would soon find themselves fitter for a hospital than for action and the pursuit of business.

These observations I acknowledge myself to have borrowed of a late ingenious

Mr. Clopton  
Havers,

\* writer of *Osteology*, who thus concludes his discourse upon this subject

Part II. subject. A visible force are deeply contrived can never be evidenced parts in structure motion. benefit a them,

More in the case the body employed for light noted, to be made the far vision bones. great value to fence toward thin, the danger elastic the hand serves oil for and in the menti them suppl the m which from

ject. And here we cannot avoid the notice of the visible footsteps of an infinite reason, which as they are deeply impressed upon the universe, so more especially on the sensible parts of it in those rational contrivances which are found in animals: And we can never sufficiently admire the wisdom and providence of our great Creator, who has given all parts in these animated Beings, not only such a structure as renders them fit for their necessary motions and designed functions, but withal the benefit and advantage of whatever may preserve them, or facilitate their action.

Moreover, the artifice of nature is wonderful in the construction of the bones that are to support the body, and to bear great burdens, or to be employed in strong exercises, they being made hollow, for lightness and stiffness. For we have before noted, a body that is hollow may be demonstrated to be more rigid and inflexible than a solid one of the same substance and weight; so that here is provision made for the stiffness and lightness of the bones. But the ribs, which are not to bear any great weight, or to be strongly exercised, but only to fence the breast, have no cavity in them, and towards the fore part or breast are broad and thin, that so they might bend and give way without danger of fracture; when bent returning by their elastick property to their figure again. Yet is not the hollow of the bones altogether useless, but serves to contain the marrow, which supplies an oil for the maintaining and inunction of the bones and ligaments, and so facilitating their motion in the articulations; and particularly (which we mentioned not before) of the ligaments, preserving them from dryness and rigidity, and keeping them supple and flexible, and ready to comply with all the motions and postures of that moveable part to which they appertain; and lastly, to secure them from disruption, which as strong, as they are, they



they would be in some danger of, upon a great and sudden stretch and contortion, if they were dry, &c. See more to this purpose in the treatise fore-quoted, p. 183.

That whereas the *breast* is encompassed with ribs, the *belly* is left free, that it might give way to the motion of the midriff in respiration, and to the necessary reception of meat and drink, as also for the convenient bending of the body; and in females for that extraordinary extension that is requisite in the time of their pregnancy.

That the lungs should be made up of such innumerable air-pipes and vesicles, interwoven with blood-vessels, in order to purify, ferment, or supply the sanguineous mass with nitro-aerial particles, which rush in by their elastick power upon the muscular extension of the thorax, and so feed the vital flame and spirits; for upon obstructing this communication all is presently extinct, no circulation, no motion, no heat, nor any sign of life remains.

That the *stomach* should be membranous, and capable of dilatation and contraction, according to the quantity of meat contained in it; that it should be situate under the liver, which by its heat might cherish it, and contribute to concoction; that it should be endued with an acid or glandulous ferment, or some corruptive quality, for so speedy a dissolution of the meat and preparation of chyle; that after concoction it should have an ability of contracting itself, and turning out the meat.

That the *guts* should immediately receive it from the *pylorus*, farther elaborate, prepare and separate it, driving by their peristaltick motion the chyle into the lacteals, and the excrementitious parts to the podex, from whence there is no regress, unless when the valve of the colon is torn and relaxed. But for the curious structure of these parts

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parts see more in *Kerkringius, Glisson, Willis, and Preyer.*

That the bladder should be made of a membranous substance, and so extremely dilatable, for receiving and containing the urine till opportunity of emptying it; that it should have shuts for the ends of the ureters, so artificially contrived as to give the urine free entrance, but to stop all passage backward, so that they will not transmit the wind, tho' it be strongly blown and forced in.

That the *liver* should continually separate the choler from the blood, and empty it into the intestines, where there is good use for it, not only to provoke dejection, but also to attenuate the chyle, and render it so subtile and fluid as to enter in at the orifices of the lacteous vein.

That in the *kidneys* there should be such innumerable little siphons or tubes, conveying the urinous particles to the pelves and ureters, first discovered by *Bellini*, and illustrated by *Malpighi*; that indeed all the glands of the *body* should be conglomerates of various sorts of vessels cured, circumgyrated and complicated together, whereby they give the blood time to stop and separate thro' the pores of the capillary vessels into the secretory ones, which afterwards all exonerate themselves into one common *Ductus*; as may be seen in the works of *Dr. Wharton, Graaf, Bartholine, Rudback, Balsius, Malpighi, Nuck*, and others. That the glands, should separate such variety of humours, all different in colour, taste, smell, and other qualities.

Finally, That all the bones, and all the muscles, and all the vessels of the body, should be so admirably contrived, and adapted, and compacted together for their several motions and uses, and that most *geometrically*, according to the strictest rules of *Mechanicks*; that if in the whole body you change the figure, situation and conjunction of one part, if you diminish or increase the bulk

bulk and magnitude ; in fine, if you endeavour the undo  
any innovation or alteration, you marr and spo Pechlin, B.  
instead of mending ; how can all these things pe vast sacks  
together but beget wonder and astonishment ? collection

In the muscles alone there seems to be mo the Lymph  
Geometry than in all the artificial engines in the and exone  
world ; and therefore the different motions between t  
animals are a subject fit only for the great Mathe Those p  
maticians to handle, amongst whom *Steno*, D use in the  
*Croon*, and above all, *Alphonso Borelli*, have ma spaces, as  
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That under one skin there should be such infin cherish an  
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interfering one with another, or hindring each othe and fastin  
motions, that they do all friendly conspire, beasts, as  
help and assist mutually one the other, all concu ture as b  
in one general end and design, the good all winte  
preservation of the whole, are certainly argumen own fat  
and effects of infinite wisdom and council ; up in its  
that he must needs be worse than mad that can Rabber,  
in his heart to imagine all these to be casual itself wa  
fortuitous, or not provided and designed by a mo bove a p  
wise and intelligent cause. and mus

Every part is cloathed, joined together and co on the c  
roborated by membranes, which upon several forth ag  
cations (as extravasations of humours, compre in thos  
sions or obstructions of vessels) are capable of serves f  
prodigious extension, as we see in the hydatides that the  
the female testicles or ovaries, in hydropic their pa  
tumours of *Lymphæducts*, of the *Scrotum* about t  
*Peritonæum*, out of the last of which alone twenty By w  
and even forty gallons of water have been draw is separ  
by a *Parasentesis*, or tapping ; for which we hav and aga



endeavour the undoubted authority of *Tulpius*, *Meekren*,  
and *Pechlin*, *Blasius*, and other medical writers. What  
things vast sacks and bags are necessary to contain such a  
collection of water, which seems to issue from  
the *Lymphæducts*, either dilacerated or obstructed,  
and exonerating themselves into the foldings, or  
between the duplicatures of the membranes?

Those parts which one would think were of little  
use in the body, serving chiefly to fill up empty  
spaces, as the fat, if examined strictly, will be  
found very beneficial and serviceable to it. 1. To  
cherish and keep it warm, by hindring the evapo-  
ration of the hot steams of blood; as cloaths keep  
us warm in winter, by reflecting and doubling the  
heat. 2. To nourish and maintain the body for  
some time when food is wanting, serving as fuel  
to preserve and continue the natural heat of the  
blood, which requires an oily or sulphurous *Pabu-  
lum* as well as fire. Hence upon long abstinence  
and fasting the body grows lean. Hence also some  
beasts, as the *Marmotto*, or *Mus Alpinus*, a crea-  
ture as big or bigger than a *Rabbit*, which absconds  
all winter, doth (as *Hildanus* tells us) live upon its  
own fat; for in the *Autumn*, when it shuts itself  
up in its hole (which it digs with its feet like a  
Rabbit, making a nest with hay or straw to lodge  
itself warm) it is very fat; [*Hildanus* took out a-  
bove a pound and an half of fat between the skin  
and muscles, and a pound out of the *Abdomen*] but  
on the contrary, in the Spring-time, when it comes  
forth again, very lean, as the hunters experience  
in those they then take. 3. The internal fat  
serves for the defence and security of the vessels,  
that they might lie soft, and be safely conveyed in  
their passage, wherefore it is especially gathered  
about them.

By what pores, or passages, or vessels, the fat  
is separated from the blood when it is redundant,  
and again absorbed into it when it is deficient, is a

matter of curious enquiry, and worthy to be industriously sought out by the most sagacious and dextrous anatomists. The vessels wheréinto it is received, and wherein contained, are by the microscope detected to be bladders, and those doubleless perforated and pervious one into another; and tho' for their excessive subtilty and thinness they appear not in a lean body, yet seem to have been primitively formed and provided by nature to receive the fat upon occasion. Why the fat is collected chiefly about some particular parts and vessels, and not others; as for example, the reins and the caul, I easily consent with *Galen* and others the reason to be, the cherishing and keeping warm of those parts upon which such vessels are spread; so the caul serves for the warming the lower belly, like an apron or piece of woollen cloth. Hence a certain gladiator, whose caul *Galen* cut out, was so liable to suffer from the cold, that he was constrained to keep his belly constantly covered with wool; for the intestines containing a great deal of food, there to undergo its last concoction, and no vessels of blood penetrating it, and flowing thro' it to keep it warm, they had need be defended from the injuries of the external air by outward coverings. Why there should be such copious fat gather'd about the reins to inclose them, is not so easy to discern, but surely there is a great and constant heat required there, for the separation of the urine from the blood, the constant separation and excretion whereof is necessary for the preservation of life; and we see if the blood be in any degree chilled, the secretion of urine is in a great measure stopt, and the *Serum* cast upon the glandules of the mouth and throat; and if the blood be extraordinarily heated by exercise, or otherwise, it casts off its *Serum* plentifully by sweat which may be effected by the swift motion of the

blood

blood the plentiful into a l stories, sensible wrought neys. C sweat and there ther ther in a supp I shal the defi places is the effec pores on transmi I shou and for that is a body of the dark phrases curiousl This wo neither have att of it, bu and pru Philosop and tho tempted parts, an they ne And I h seems in and sub those m ever can

to be in- blood thro' the glandules of the skin, where its  
 acious and plentiful streams being strengthened and constipated  
 into it into a liquor, force their way thro' those emun-  
 by the mi- stries, which at other times transmit only in-  
 ose doubt- sensible vapours. Some such effects may be  
 other; and wrought upon the blood by the heat of the kid-  
 nesses they neys. Certain it is that the humours excerned by  
 have been sweat and urine are near a-kin, if not the same;  
 ture to re- and therefore it is worthy the consideration, whe-  
 fat is col- ther there might not be some use made of sweating  
 ts and ves- in a suppression of urine. But I digress too far.

the reins I shall only add to this particular, that because  
 ten and o- the design of nature in collecting fat in these  
 nd keeping places is for the fore-mentioned use, it hath for  
 vessels are the effecting thereof fitted the vessels there with  
 arming the pores or passages proper for the separation and  
 of woolen transmission of it.

se caul Ga- I should now proceed to treat of the generation  
 n the cold, and formation of the *Fœtus* in the womb, but  
 y constant that is a subject too difficult for me to handle, the  
 containing body of man and other animals being formed in  
 its last con- the dark recesses of the *Matrix*, or, as the *Psalmist*  
 ating it, and phrases it, *Psal. cxxxix. 14. made in secret, and*  
 had need be *curiously wrought in the lowest parts of the earth.*  
 ernal air by This work is so admirable and unaccountable, that  
 ould be sud- neither the atheists nor mechanical philosophers  
 nclose them, have attempted to declare the manner and process  
 re is a great of it, but have (as I noted before) very cautiously  
 e separation and prudently broke off their systems of natural  
 tant separa- Philosophy here, and left this point untouched;  
 ary for the and those accounts which some of them have at-  
 blood be in- tempted to give of the formation of a few of the  
 urine is in parts, are so excessively absurd and ridiculous, that  
 ft upon the they need no other confutation than *ha, ha, he.*  
 and if the And I have already further shewn, that to me it  
 ercise, or o- seems impossible that matter divided into as minute  
 ly by sweat and subtile parts as you will or can imagine, and  
 otion of the those moved according to what catholick laws so-  
 blood ever can be devised, should without the presidency



and direction of some intelligent agent, by the mere agitation of a gentle heat, run itself into such a curious machine as the body of man is.

Yet must it be confessed that the seed of animals is admirably qualified to be fashioned and formed by the *Plastick Nature* into an organical body, containing the principles or component particles of all the several homogeneous parts thereof; for indeed every part of the body seems to club and contribute to the seed, else why should parents that are born blind or deaf, or that want a finger or any other part, or have one superfluous, sometimes generate children that have the same defects or imperfections; and yet (which is wonderful) nothing of the body or grosser matter of the seed comes near the first principle of the *Fœtus*, or in some so much as enters the womb, but only some contagious vapour or subtile *effluvia* thereof, which seems to animate the *Gemma* or *Cicatrix* of the egg contained in the female *Ovary* before it passes thro' the *Tubes* or *Cornua* into the *Uterus*. How far the animalcules observed in the seed of males may contribute to generation, I leave to the more sagacious philosophers to enquire, and shall here content myself with referring the reader to the several letters published by Mr. *Lewenhoeck*.

But to what shall we attribute the *Fœtus* in likeness to the parents, or, omitting them, to the precedent progenitors; as I have observed, some parents that have been both black-haired, to have generated most red-haired children; because their ancestors hair hath been of that colour? Or why are twins so often extremely alike? Whether this is owing to the efficient, or to the matter?

Those *effluvia* we speak of in the male seed as subtile as they are, yet have they a great, if not the greatest stroke in generation, as is clearly demonstrable in a mule, which doth more resemble the male parent, that is, the ass, than the female

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or horse. But now, why such different *species* should not only mingle together, but also generate an animal, and yet that that hybridous production should not again generate, and so a new race be carryed on, but nature should stop here, and proceed no farther, is to me a mystery, and unaccountable.

One thing relating to generation I cannot omit; that is, the construction of a sett of temporary parts (like scaffolds in a building) to serve a present end, which are afterwards laid aside, afford a strong argument of council and design. Now for the use of the young during its inclosure in the womb there are several parts formed, as the membranes inveloping it, called the *Secundines*, the umbilical vessels, one vein, and two arteries; the *Urachus*, to convey the urine out of the bladder, and the *Placenta Uterina*; part whereof fall away at the birth, as the *Secundines* and *Placenta*; others degenerate into the ligaments, as the *Urachus*, and part of the umbilical vein; besides which, because the *Fœtus* during its abode in the womb hath no use of respiration by the lungs, the blood doth not all, I may say, not the greatest part of it, flow through them, but there are two passages or channels contrived, one called the *Foramen Ovale*, by which part of the blood brought by the *Vena Cava* passeth immediately into the left ventricle of the heart, without entering the right at all; the other is a large arterial channel passing from the pulmonary artery immediately into the *Aorta*, or great artery, which likewise derives part of the blood thither, without running at all into the lungs; these two are closed up soon after the child is born, when it breathes no more (as I may so say) by the *Placenta Uterina*, but respiration by the lungs is needful for it. It is here to be noted, that tho' the lungs be formed so soon as the other parts, yet during the abode of the *Fœtus* in the womb they lie by as useless. In like

manner I have observed, that in ruminating creatures the three foremost stomachs, not only during the continuance of the young in the womb, but so long as it is fed with milk, are unemployed and useless, the milk passing immediately into the fourth.

Another observation I shall add concerning generation, which is of some moment, because it takes away some concessions of naturalists that give countenance to the atheists fictitious and ridiculous account of the first production of mankind and other animals, *viz.* That all sorts of insects, yea, and some quadrupeds too, as frogs and mice, are produced spontaneously. My observation and affirmation is, that there is no such thing in nature as equivocal or spontaneous generation, but that all animals, as well small as great, not excluding the vilest and most contemptible insect, are generated by animal parents of the same *species* with themselves; that noble *Italian* virtuoso *Francisco Redi* having experimented, that no putrified flesh (which one would think were the most likely of any thing) will of itself, if all insects be carefully kept from it, produce any. The same experiment I remember *Dr. Wilkins*, late bishop of *Chester*, told me had been made by some of the *Royal society*. No instance against this opinion doth so much puzzle me as worms bred in the intestines of man and other animals. But seeing the round worms do manifestly generate, and probably the other kinds too, it is likely they come originally from seed, which, how it was brought into the guts, may afterwards possibly be discovered. Moreover, I am inclinable to believe that all plants too, that themselves produce seed (which are all but some very imperfect ones, which scarce deserve the name of plants) come of seed themselves. For the great naturalist *Malpighius*, to make experiment whether earth would of itself

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put forth plants, took some purposely digged out of a deep place and put it into a glass vessel, the top whereof he covered with silk many times doubled, and strained over it, which would admit the water and air to pass thro', but exclude the least seed that might be waisted by the wind; the event was, that no plant at all sprang up in it. Nor need we wonder how in a ditch, bank or grass-plant newly digged, or in the fen-banks in the *Isle of Ely*, mustard should abundantly spring up, where in the memory of man none hath been known to grow, for it might come of seed which had lain there more than a man's age, some of the antients mentioning some feeds that retain their fecundity forty years; and I have found in a paper received from a friend, but whom I have forgotten, that melon-seeds after thirty years are best for raising of melons. As for the mustard that sprung up in the *Isle of Ely*, tho' there had never been any in that country, yet might it have been brought down in the channels by the floods, and so being thrown up the banks together with the earth, might germinate and grow there.

And indeed a spontaneous generation of animals and plants, upon due examination, will be found to be nothing less than a creation of them; for after the matter was made, and the sea and dry land separated, how is the creation of plants and animals described, but by a commanding, that is, effectually causing the waters and earth to produce their several kinds without any seed? Now creation being the work of Omnipotency, and incommunicable to any creature, it must be beyond the power of nature or natural agents to produce things after that manner. And as for God Almighty, he is said to have rested from his work of creation after the seventh day. But if there be any spontaneous generation, there was

nothing done at the creation but what is daily done ; for the earth and water produced animals then without seed, and so they do still.

Because some, I understand, have been offended at my confident denial of all spontaneous generation, accounting it too bold and groundless, I shall a little enlarge upon it, and give my reasons, in order to their satisfaction.

*First*, Then, I say, such a spontaneous generation seems to me to be nothing less than a creation ; for creation being not only a production of a thing out of nothing, but also out of indisposed matter, as may be clearly inferred from the scripture, and is agreed by all divines, this spontaneous generation being such a production, wherein doth it differ from creation ? Or what did God Almighty do at the first creation of animals and plants more than what (if this be true) we see every day done ? To me, I must confess, it seems almost demonstrable, that whatever agent can introduce a form into indisposed matter, or dispose the matter in an instant, must be superior to any natural one, not to say omnipotent.

*Secondly*, Those who have with the greatest diligence and application considered and searched into this matter, as those eminent virtuosi, *Morcellus Malpighius, Franciscus Redi, John Swammerdam, Lewenhoeck*, and many others, are unanimously of this opinion, save that *Franciscus Redi* would except such insects as are bred in galls, and some other excrescencies of plants. Now their authority weighs more with me than the general vogue, or the concurrent suffrages of a thousand others, who never examined the things so carefully and circumspectly as they have done, but run away with the cry of the common herd of philosophers.

First of all, *Dr. Swammerdam*, who hath been, to the best purpose of any man I know of, busied in searching out and observing the nature of all in-

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sects in general; all in general I say, for as to one particular insect, to wit, the silk-worm, I must except Signior *Malpighi*; and to one Genus of them, to wit, spiders, Dr. *Lister*, in his general history of insects, written in *Low Dutch*, and translated into *French*, p. 47. hath these words, *Nous disons qu'il ne se fait dans toute la nature aucune generation par accident, &c. We affirm that there is not in all nature any accidental [or spontaneous] generation, but all come by propagation; wherein chance hath not the least part or interest.* And in p. 159. speaking of the generation of insects out of plants, in contradiction I suppose to Signior *Redi*, he saith, *Nous croyons absolument, &c. We do absolutely believe that it is not possible to prove by experience that any insects are engendered out of plants; but on the contrary, we are very well informed and assured, that these little animals are not shut up in or inclosed there for any other reason than to draw thence their nourishment.* It is true indeed, that by a certain, constant, and immutable order of nature, we see many sorts of insects affixed to particular species of plants and fruits, to which the respective kinds fasten themselves as it were by instinct; but we are to know that they all come of the seed of animalcules of their own kind, that were before laid there; for these insects do thrust their seed or eggs so deep into the plants, that they come to be afterwards as it were united with them, and the aperture or orifice by which they entered quite closed up and obliterated, the eggs being hatched and nourished within. We have often found the eggs of insects so deeply sunk into the tender buds of trees, that without hurting of them it was impossible to draw them out. Many instances he produces in several sorts of insects making their way into plants, which tho' they be well worth the reading, are too long to transcribe.

*Secondly,*



Secondly, That great and sagacious naturalist, and most accurate examiner of these things, Signior *Malpighi*, in his treatise of *Galls*, under which name he comprehends all preternatural and morbose tumours and excrescencies of plants; doth demonstrate in particular, that all such warts, tumours and excrescencies, where any insects are found, are excited or raised up either by some venenose liquor, which together with their eggs such insects shed upon the leaves, or buds, or fruits of plants, or boring with their *Terebræ*, instill into the very pulp of such buds or fruits; or by the contagious vapour of the very eggs themselves, producing a mortification or syderation in the parts of plants on which they are laid; or lastly, by the grubs or maggots hatched of the eggs laid there, making their way with their teeth into the buds, leaves or fruit, or even the wood itself of such plants on which their eggs are laid. So that at the last he concludes: *Erunt itaque gallæ & reliqui plantarum tumores morbosæ excrescentiæ, vi depositi ovi a turbata plantarum compage, & vitiato humorum motu excitatæ, quibus inclusa ova & animalcula velut in utero foventur & augentur, donec manifestatis firmatissimæ propriis partibus, quasi exoriantur novam exoptantia auram.* We conclude therefore that galls, and other tumors of plants, are nothing else but morbose excrescencies, raised up by the force of the eggs there laid, disturbing the vegetation and temper of the plants, and perverting the motion of their humours and juices; wherein the inclosed eggs and animalcules are cherished, nourished, and augmented, till their proper parts being manifested, explicated, and hardened, or strengthened, they are as it were new born, affecting to come forth into the open air. In the same treatise he describes the hollow instrument (*Terebra* he calls it, and we may english it *Piercer*) wherewith many flies are provided

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vided, proceeding from the womb, with which they perforate the teguments of leaves, fruits or buds, and through the hollow of it inject their eggs into the holes, or wounds which they have made, where in process of time they are hatched and nourished. This he beheld one of these insects doing with his own eyes in the bud of an oak; the manner whereof he describes, p. 47. which I shall not transcribe, only take notice, that when had taken off the insect he found in the leaf very little and diaphanous eggs, exactly like to those which yet remained in the tubes of the fly's womb. He adds further, that it is probable that there may be eggs hidden in divers parts of plants, whereof no footstep doth outwardly appear, but the plant remains as entire and thrives as well as if there were no insect there; nay, that some may be hidden and cherished in dry places (not wanting any humour to feed them) as in fear-wood, yea, in earthen vessels, and marbles themselves.

Indeed to me it seems unreasonable that plants, being of a lower form or order of being, should produce animals; for either they must do it out of indisposed matter, and then such production would amount to a creation, or else they must prepare a fit matter, which is to act beyond their strength, there being required to the preparation of the sperm of animals a great *Apparatus* of vessels, and many secretions, concoctions, reflections, digestions and circulations of the matter, before it can be rectified and exalted into so noble a liquor; and besides there must be an egg too; for we know *ex ovo omnia*; to the perfection whereof there are as many vessels and as long a process required. Now in plants there are no such vessels and consequently no such preparation of eggs or sperm, which are the necessary principles of animals.

*Thirdly*, That worthy author of our own country, I mean Dr. *Lister*, in his notes upon *Geodartius*

tius insect. Numb. 16. p. 47. hath these words: *Non enim inducor ut credam, hoc, vel aliud quodvis animal, modo quodam spontaneo e planta produci, & alii causæ cuicunque originem suam debere quam parenti animali; i. e. I cannot be persuaded or induced to believe, that this, or any other animal, is (or can be) produced out of a plant in a spontaneous manner, or doth owe its origination to any other cause whatever, than an animal parent of its own kind.* And in his third note upon *Insect. Numb. 49.* these: *Quoad spontaneam erucæ hujus aliorumque insectorum generationem pro parte negativa jam sententiam meam tradidi &c.* As to the spontaneous generation of this *Eruca* and other insects, I have already delivered my opinion for the negative. This is most certain that these *Cossi* are produced of eggs laid by animal parents: It is also alike clear, that these diminutive caterpillars are able by degrees to pierce or bore their way into a tree; which very small holes, after they are fully entered, do perchance grow together, and quite disappear, at least become so small, that they are not to be discerned, unless by Lynceus's eyes. Add moreover, that perchance they undergo no transformation, but continue under the vizard of [*Erucae*] caterpillars for many years, which doth very well accord with my observations. Moreover, that this caterpillar [*Eruca*] is propagated by animal parents, to wit Butterflies, after the common origination of caterpillars. In all this I fully consent with the Dr. only crave leave to differ in his attributing them the name of *Cossi* which were accounted by the antients a delicate morsel, and food for the table; for I take those to have been the hexapods, from which the greater sort of beetles come; for that sort of hexapods are at this day eaten in our American plantations, as I am informed by my good friend Dr. Hans Sloane, who also presented me

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with a glass of them preserved in spirit of wine.

Having lately had an opportunity more curiously to view and examine the great flesh-coloured, thin-haired, *English* caterpillar (which is so like that sent me by Dr. Sloane, that it differs little but in magnitude, which may be owing to the climate) I observed that it had a power of drawing its eight hind legs or stumps so far up in its body that they did altogether disappear, so that the creature seemed to want them, and of thrusting them out again at pleasure; whereupon I conjectured, that that insect of *Jamaica* sent me by the Dr. (which I took to be the *Cossus* or *Hexapod*, previous to some large beetle) had likewise the same power of drawing up its hind legs, so that tho' to appearance it wanted them, yet really it did not so, but had only drawn them up and hid them in its body when it was immersed in the spirit of wine, and consequently was not the *Hexapod* of a beetle, but an *Eruca*, like to, or indeed specifically the same with that of our own country by me observed; and being eaten at this day by the inhabitants of *Jamaica*, is in all likelihood the same with the *Cossus* of the antient *Romans*, which was food for the table, as *Pliny* assures; especially if we consider, that Dr. *Lister* found this *Eruca* in the body of an oak newly cut down and sawed in pieces; on which tree *Pliny* saith they feed. Thus much I thought fit to add to Dr. *Lister*, and do the truth right, by retracting my former conjecture concerning the *Cossi*.

3. My third argument against spontaneous generation is, because there are no arguments or experiments which the patrons of it do or can produce which do clearly evince it. For the general and vulgar opinion that the heads of children, or the bodies of those that do not change their linen, but wear that which is sweaty and sordid, breeds lice; or that cheese of itself breeds mites or maggots; I deny, and look upon it as a great error and

and mistake; and do affirm, that all such creatures are bred of eggs laid in such sordid places by some wandering louse, or mite, or maggot; for such places being most proper for the hatching and exclusion of their eggs, and for the maintenance of their young, nature hath endowed them with a wonderful acuteness of scent and sagacity, whereby they can, tho' far distant, find out and make towards them; and even lice and mites themselves, as slow as they seem to be, can, to my knowledge, in no long time march a considerable way to find out a convenient harbour for themselves.

Here, by the by, I cannot but look upon the strange instinct of this noisome and troublesome creature a louse, of searching out foul and nasty cloathes to harbour and breed in, as an effect of divine providence, designed to deter men and women from sluttishness and sordidness, and to provoke them to cleanliness and neatness. God himself hateth uncleanness, and turns away from it, as appears by Deut. xxiii. 12, 13, 14. But if God requires and is pleased with bodily cleanliness, much more is he so with the pureness of the mind, *Blessed are the pure in heart, for they shall see God*, Mat. v. 10.

As for the generation of insects out of a putrid matter, the experiments of *Franciscus Redi*, and some of our own *Virtuosi*, give me sufficient reason to reject it. I did but just now mention the quick scent that insects have, and the great sagacity in finding out a proper and convenient harbour or *Matrix* to cherish and hatch their eggs and feed their young; they are so acted and directed by nature, as to cast their eggs in such places as are most accommodated for the exclusion of their young, and where there is food ready for them as soon as they be hatched; nay, it is a very hard matter to keep off such insects from shedding their seed

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seed in such proper places. *Indeed if an insect may be thus equivocally generated, why not sometimes a bird, a quadruped, a man, or even an universe? Or, why no new species of animals now and then? As my learned friend Dr. Tancred Robinson very well argues in his letter; for there is as much art shewn in the formation of those as of these.*

A fourth and most effectual argument against spontaneous generation is, that there are no new species produced, which would certainly now and then, nay, very often happen were there any such thing; for in such pretended generations, the generant or active principle is supposed to be the sun, which being an inanimate body, cannot act otherwise than by his heat, which heat can only put the particles of the passive principle into motion; the passive principle is putrid matter, the particles whereof cannot be conceived to differ in any thing but figure, magnitude and gravity; now the heat putting these particles in motion, may indeed gather together those which are homogeneous, or of the same nature, and separate those that are heterogeneous, or of a different, but that it should so situate, place and connect them as we see in the bodies of animals, is altogether inconceivable; which if it could, yet that it should always run them into such a machine as is already extant, and not often into some new-fashioned one, such as was never seen before, no reason can be assigned or imagined. This the *Epicurean* Poet *Lucretius* was so sensible of, that he saw a necessity of granting seeds or principles to determine the species. For (saith he) if all sorts of principles could be connected;

—*Vulgo fieri portenta videres,  
Semiferas hominum species existere, & altos  
Interdum ramos eigni corpore vivo;  
Multaque connecti terrestria membra marinis;*



*Tum flammam retro spirantis ore chimæras  
 Pascere naturam per terras omniparenteis,  
 Quorum nil fieri manifestum est, omnia quando  
 Seminibus certis, certa genetrice, creata  
 Conservare genus crescentia posse videmus, &c.*

That is——Thence would rise  
 Vast monsters, nature's great absurdities;  
 Something half beast, half man, and some would grow  
 Tall trees above, and animals below,  
 Some join'd of fish and beasts, and every where  
 Frightful Chimaera's breathing flames appear.  
 But since we see no such, and things arise  
 From certain seeds, of certain shape and size,  
 And keep their kind as they increase and grow,  
 There's some fix'd reason why it should be so.

The raining of frogs, and their generation in the clouds, tho' it may be attested by many and great authors, I look upon as utterly false and ridiculous; it seems to me no more likely that frogs should be engendered in the clouds, than *Spanish* gennets begotten by the wind, for that hath good authors too; and he that can swallow the raining of frogs, hath made a fair step towards believing that it may rain calves also, for we read that one fell out of the clouds in *Avicen's* time; nor do they much help the matter, who say, that those frogs that appear sometimes in great multitudes after a shower, are not indeed engendered in the clouds, but coagulated of a certain sort of dust commixed and fermented with rain-water; to which hypothesis *Fromondus* adheres.

But let us a little consider the generation of frogs in a natural way. 1. There are two different sexes, which must concur to their generation, 2. There is both a great *Apparatus* of spermatic vessels, wherein the nobler and more spirituous part of the blood is by many digestions, concocti-

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ons, reflections and circulations exalted into that generous liquor we call sperm; and likewise for the preparing of the eggs. 3. There must be a copulation of the sexes, which I rather mention because it is the most remarkable in this that ever I observed in any animal; for they continue in *complexu venereo* at least a month indefinitely, the male all that while resting on the back of the female clipping and embracing her with his legs about the neck and body, and holding her so fast, that if you take him out of the water he will rather bear her whole weight than let her go; this I observed in a couple kept on purpose in a vessel of water by my learned and worthy friend Mr. *John Nid*, fellow of *Trinity-College*, long since deceased; after this the spawn must be cast into water, where the eggs lie in the midst of a copious jelly, which serves them for their first nourishment for a considerable while; and at last the result of all is not a perfect frog, but a tadpole, without any feet, and having a long tail to swim withal; in which form it continues a long time, till the limbs be grown out and the tail fallen away, before it arrives at the perfection of a frog.

Now if frogs can be generated spontaneously in the clouds out of vapour, or upon the earth out of dust and rain-water, what needs all this a-do? To what purpose is there such an *Apparatus* of vessels for the elaboration of the sperm and eggs? such a tedious process of generation and nutrition? This is but an idle pomp; the sun (for he is supposed to be the equivocal generant or efficient by these philosophers) could have dispatched the business in a trice; give him but a little vapour, or a little dry dust and rain-water, he will produce you a quick frog, nay, a whole army of them, perfectly formed, and fit for all the functions of life, in three minutes, nay, in the hundredth part of one minute, else must some of those frogs

that were generated in the clouds fall down half formed and imperfect, which I never heard they did; and the process of generation have been observed in the production of frogs out of dust and rain-water, which no man ever pretended to mark or discern. But that there can be no frogs generated in the clouds, may further be made appear, 1. From the extreme cold of the middle region of the air, where the vapours are turned into clouds, which is not at all propitious to generation; for did not so great men as *Aristotle* and *Erasmus* report it, I could hardly be induced to believe that there could be one *Species* of insects generated in snow. 2. Because if there were any animals engendered in the clouds, they must needs be maimed and dashed in pieces by the fall, at least such as fell in the high-ways, and upon the roofs of houses; whereas we read not of any such broken or imperfect frogs found any where. This last argument was sufficient to drive off the learned *Fromondus* from the belief of their generation in the clouds; but the matter of fact he takes for granted, I mean, the spontaneous generation of frogs out of dust and rain-water, from an observation or experiment of his own at the gates of *Tournay* in *Flanders*, to the sight of which spectacle he called his friends who were there present, that they might admire it with him. *A sudden shower* (saith he) *falling upon the very dry dust, there suddenly appeared such an army of little frogs, leaping about every where upon the dry land, that there was almost nothing else to be seen; they were also of one magnitude and colour; neither did it appear out of what lurking places [Latibula] so many myriads could creep out, and suddenly discover themselves upon the dry and dusty soil, which they hate.* But saving the reverence due to so great a man, I doubt not but they did all creep out of their holes and coverts, invited by the agreeable vapour of the

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the rain-water; this, however unlikely as it may seem, is a thousand times more probable than their instantaneous and undiscernible generation out of a little dry dust and rain-water, which also cannot have any time to mix and ferment together, which is the *Hypothesis* he adheres to; nay, I affirm, that it is not at all improbable; for he that shall walk out in Summer nights, when it begins to grow dark, may observe such a multitude of great toads and frogs crawling about in the highways, paths and avenues to houses, yards, and walks of gardens and orchards, that he will wonder whence they came, or where they lurked all the winter and all the day-time, for that then it is a rare thing to find one.

To which add, that in such frogs as we are speaking of, Monsieur *Perault* hath upon dissection often found the stomach full of meat, and the intestines of excrement; whence he justly concludes, "that they were not then first formed, but "only appeared of a sudden; which is no great "wonder, since upon a shower after a drought, "earth-worms and land-snails innumerable come "out of their lurking-places in like manner.

In confirmation of what I have here written against the spontaneous generation of frogs, either in the clouds out of vapour, or on the earth out of dust and rain-water commixed, endeavouring to prove by force of argument that there is no such thing, I have lately received from my learned and ingenious friend Mr. *William Derham*, rector of *Upminster*, near *Rumford* in *Essex*, a relation parallel to that of *Fromondus*, concerning the sudden appearance of a vast number of frogs, after a shower or two of rain, marching cross a sandy way, that before the rain was very dusty, and giving an account where, in all likelihood, they were generated by animal parents, of their own kind, and whence they did proceed. The

whole narrative I shall give the reader in his own words.

"Some years ago, as I was riding forth one afternoon in *Berks*, I happened upon a prodigious multitude creeping cross the way; it was a sandy soil, and the way had been full of dust by reason of a dry season that then was; but an hour or two before a refreshing fragrant shower or two of rain had laid the dust; whereupon what I had heard or read of the raining of frogs, immediately came to my thoughts, and it easily might do, there being probably as good reason then for me, as I believe any ever had before, to conclude that these came from the clouds, or were instantaneously generated; but being prepossessed with the contrary opinion, viz. that there was no equivocal generation, I was very curious in enquiring whence this vast colony might probably come; and upon searching I found two or three acres of land covered with this black regiment, and that they all marched the same way towards some woods, ditches and such like cool places in their front, and from large ponds in their rear; I traced them backwards, even to the very side of one of the ponds: these ponds in spawning-time always used to abound much with frogs whose croaking I have heard at a considerable distance; and a great deal of spawn I have found there.

"From these circumstances I concluded that this vast colony was bred in those ponds, from whenceward they steered their course; that after their incubation (if I may so call it) or hatching by the sun, and their having passed their tadpole state, they had lived (till that time of their migration) in the waters, or rather on the shore, among the flags, rushes, and long grass; but now being invited out by the refreshing showers, then newly fallen, which

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 cluded, but withal so easy to have been disco-  
 vered by any inquisitive observer, who in former  
 times met with the like appearance, that I can-  
 not but admire that such sagacious philosophers  
 as *Aristotle*, *Pliny*, and many others since, should  
 ever imagine frogs to fall from the clouds, or  
 be any way instantaneously or spontaneously  
 generated, especially considering how openly  
 they act their coition, produce spawn, this  
 spawn tadpoles, and tadpoles frogs.

“ Neither in frogs only, but also in many other  
 creatures, as lice, flesh-flies, silk-worms, and  
 other *Papilios*, an uniform regular generation  
 was very obvious, which is an argument to me  
 of a strange prepossession of fancy in the ages  
 since *Aristotle*, not to say of carelessness and  
 sloth.” So far Mr. Derham.

In like manner doubtless *Fromondus*, had he  
 made a diligent search, might have found out the  
 place where those myriads of frogs, observed by  
 him about the gates of *Tournay*, were generated,  
 and whence they did proceed.

As for the worms and other animals bred in  
 the intestines of man and beast, I have declared  
 myself not to be satisfied of the ways and means  
 how their seeds come to be conveyed into those  
 places, but yet that their generation is analogous  
 to that of other creatures of those kinds, I doubt  
 not; the constancy of their *species*, their exact  
 agreement and perpetual similitude in the shape  
 and figure of their bodies and all the parts, their  
 consistence, temper, motion, and other accidents,  
 are to me little less than a demonstration that  
 they



they are not the effects of chance, but the products of a settled and spermatick principle; I am at present, till better informed, of opinion that their eggs are swallowed with the meat we eat; and I am the rather induced to think so, because children in their first infancy, and as long as they are constantly confined to a milk diet, are seldom troubled with them.

After this was written I received a letter from my often remembred ingenious friend Dr. *Tancred Robinson* referring to this matter, part whereof I shall transcribe, as being very pertinent, instructive, and consonant to my own thoughts. "I think it may be proved, that the vast variety of worms found in almost all the parts of different animals, as well *terrestrial* as *aquatic*, are taken into their respective bodies by meats and drinks, and there either lie still for some time, or else grow and alter by change of place and food [not specifically, but accidentally, in magnitude, colour, figure of some parts, or the like.] We know as yet but little of the numerous *Insects* bred in water, or indeed of those roots, leaves, buds, flowers, fruits and seeds, which we are continually swallowing, and these too all vary according to climate [that is, the same species of *Roots*, *Leaves*, &c. do in different climates produce many different species of insects, tho' some there be common to all] the long slender worms, as small as hairs, that breed between the skin and the flesh in the isle of *Ormuz* and in *India*, which are generally twisted out upon sticks or rowlers, and often break in the operation, are without doubt taken in by the water they drink in those regions, as I could prove by many and good experiments had I time. They who have leisure may find them in the collections of voyages and travels, especially in Monsieur

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*Thevenot.* By this explication we may give a better account of the vomitings-up of tadpoles, snails, and other animals, recorded in medical histories, than by any hypothesis of equivocal generation. As to insects found in stinking flesh or rotten vegetables, I could never observe or find any of them different from those parent-insects which hover about or feed upon such bodies."

If any shall object the infinite multitudes of animalcules discovered in pepper-water, and desire an account of their generation: to him I shall say, that it is probable that some few of these animals may be floating in all waters, and that finding the particles of pepper swimming in the water, very proper for the cherishing and excluding of their eggs, by reason of their heat, or some other unknown and specifick quality, they may fasten their eggs to them, and so there may be a sudden breed of infinite swarms of them; but these being not to be discerned by the most piercing and *Lyncean* sight without the assistance of a microscope, I leave the manner of their generation to future discovery.

No less difficult is it to give an account of the original of such insects as are found, and seem to be bred in the bodies of others of different kinds. Out of the sides and back of the most common caterpillar, which feeds upon cabbage, colewort, and turnep-leaves, which we have described in the Catalogue of *Cambridge Plants*, we have seen creep out small maggots to the number sometimes of threescore or more, which so soon as ever they come forth began to weave themselves silken cases of a yellow shining colour, wherein they changed, and after some time came out thence in the form of small flies with four wings; for a full description and history whereof I shall refer the reader to the fore-mentioned Catalogue.

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The like I have also observed in other caterpillars of a different kind, who have produced no less number of maggots, that in like manner immediately made themselves up in cases. Others, instead of changing into *Aurelia*'s, as in the usual process of nature they ought to do, have turned into one, two, or three, or more flesh-fly-cases at least contained such cases within them, out of which after a while were excluded flesh-flies. Other caterpillars, as that called the *solitary Maggot*, found in the dry heads of teasel, by a dubious *Metamorphosis*, sometimes changed into the *Aurelia* of a butterfly, sometimes into a fly-case. You may say, how comes this to pass? Must we not here necessarily have recourse to a spontaneous generation? I answer, No; the most that can be inferred from hence is, a transmutation of *Species*; one insect may, instead of generating another of its own kind, beget one or more of a different kind; but I can by no means grant this; I do believe that these flies do either cast their eggs upon the very bodies of the fore-mentioned caterpillars, or upon the leaves on which they feed, all in a string, which there hatching, eat their way into the body where they are nourished till they be come to their full growth; or it may be the fly may with the hollow and sharp tub of her womb punch and perforate the very skin of the *Eruca*, and cast her eggs into its body; so the *Ichneumon* will convert her eggs into caterpillars.

The discovery of the manner of the generation of these sorts of insects I earnestly recommend to all ingenious naturalists as a matter of great moment; for if this point be but cleared, and it be demonstrated that all creatures are generated univocally by parents of their own kind, and that there is no such thing as spontaneous generation in the world, one main prop and support of Atheism is taken away, and their strongest hold demolished.

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But you for; the in the stomach of it, may fit *Latitudo* big to re-entered many y-ness of ficing in stone, not, for those were ed, the whereb or else matter small t-able to the main t-



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they cannot then exemplify their foolish *Hypothesis* of the generation of man and other animals at first by the like of frogs and insects at this present day.

It will be farther objected that there have live toads been found in the midst of timber trees, nay, of stones when they have been sawn asunder. To this I answer, that I am not fully satisfied of the matter of fact; I am so well acquainted with the credulity of the vulgar, and the delight they, and many of the better sort too, have in telling of wonders and strange things, that I must have a thing well attested before I can give a firm assent to it.

Since the writing hereof, the truth of these relations, of live toads found in the midst of stones, hath been confirmed to me by sufficient and credible eye-witnesses, who have seen them taken out; so that there is no doubt of the matter of fact.

But yet, suppose it be true, it may be accounted for; those animals when young and little finding in the stone some small hole reaching to the middle of it, might, as their nature is, creep into it, as a fit *Latibulum* for the winter, and grow there too big to return back by the passage by which they entered, and so continue imprisoned therein for many years, a little air, by reason of the coldness of the creature, and its lying torpid there, sufficing it for respiration; and the humour of the stone, by reason it lay immoveable, and spent not, for nourishment; and I do believe that if those who found such toads had diligently searched, they might have discovered and traced the way whereby they entered in, or some footsteps of it; or else they might fall down into the lapideous matter, before it was concrete into a stone, some small toad (or some toad-spawn) which being not able to extricate itself and get out again, might remain there imprisoned till the matter about it were

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condensed and compacted into a stone; but how ever it came there, I dare confidently affirm it was not there spontaneously generated; for else either there was such a cavity in the stone before the toad was generated, which is altogether improbable, and *gratis dictum*, asserted without any ground, or the toad was generated in the solid stone, which is more unlikely than the other, in that the soft body of so small a creature should extend itself in such a prison, and overcome the strength and resistance of such a great and ponderous mass of solid stone.

And whereas the assertors of equivocal generation were wont to pretend the imperfection of these animals as a ground to facilitate the belief of their spontaneous generation, I do affirm that they are as perfect in their kind, and as much art shewn in the formation of them as of the greatest, nay, more too in the judgment of that great wit and

natural Historian \* Pliny. *In magnis*  
 \* Lib. 11. *siquidem corporibus* (saith he) *aut certe*  
 cap. 2. *majoribus facilis officina sequaci mate-*

*ria fuit; in his tam parvis atque tam nullis, quæ ratio, quanta vis, quam inextricabilis perfectio?*  
 In the greater bodies the forge was easy, the matter being ductil and sequacious, obedient to the hand and stroke of the artificer, apt to be drawn, formed or moulded into such shapes and machines even by clumsy fingers; but in the formation of these, such diminutive things, such nothings, what cunning and curiosity! what force and strength was requisite, there being in them such inextricable perfection!

To what proofs or examples of spontaneous generation may be brought from insects bred in the fruits or excrescencies of plants, I have already made answer in my second particular, which contains the testimonies of our best modern naturalists concerning these things.

In my denial of the spontaneous generation of

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plants, I yet there against it would and conf is dispos the heat I reply, strength nothing prior, wh preparat or instru that App as I all Feminin ther, w generati trees, e up with did or c they can why the differen species

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Part II. *plants*, I am not so confident and peremptory; but yet there are the same objections and arguments against it as against that of animals, *viz.* because it would be a production out of indisposed matter, and consequently a Creation; or if it be said there is disposed matter, prepared by the earth, or sun, the heat, or whatever other agent you can assign; I reply, this is to make a thing act beyond its strength, that is, an inferior nature, which hath nothing of life in it, to prepare matter for a superior, which hath some degree of life, and for the preparation of which it hath no convenient vessels or instruments; if it could do so, what need of all that *Apparatus* of vessels, preparation of seed, and, as I also suppose, distinction of Masculine and Feminine that we see in plants? I demand farther, whether any of the patrons of spontaneous generation in plants did ever see any herbs or trees, except those of the grass-leaved tribe, come up without two seed-leaves? which if they never did or could, it is to me a great argument that they came all of seed, there being no reason else why they should at first produce two seed-leaves different from the subsequent; and if all these *species* (which are far the greatest number) come from seed, there is not the least reason to think that any of the rest come up spontaneously; and this, with what I have written before, may suffice concerning this point.

Whereas I have often written in many places that such and such plants are spontaneous, or come up spontaneously, I mean no more by that expression but that they were not planted or sown there industriously by man.

Having spoken of the body of man, and the uses of its several parts and members, I shall add some other observations, giving an account of the particular structure, actions and uses of some parts, either common to whole kinds of animals, or proper



per to some particular *species*, different from those of man, and of the reason of some instincts and actions of brutes.

*First* of all, the manner of respiration, and the organs serving thereto in various animals, are accommodated to their temper of body, and their place and manner of living; of which I have observed in more perfect animals three differences.

1. The hotter animals, which require abundance of spirits for their various motions and exercises, are provided with lungs, which indefinitely draw in and expel the air alternately, without intermission, and have a heart furnished with two ventricles; because to maintain the blood in that degree of heat which is requisite to the performance of the actions of all the muscles, there is abundance of air necessary. I shall not now take notice of the difference that is between the lungs of quadrupeds and birds, how the one are fixed and immovable, the other loose and movable; the one perforated, transmitting the air into large bladders, the other inclosed with a membrane.

It is here worth the notice taking, that many animals of this kind, both birds and quadrupeds, will endure and bear up against the extreme rigor of cold that our country is exposed to: *Horse, Kine, and Sheep*, as I have experienced, will lie abroad in the open air upon the cold ground during our long winter nights, in the sharpest and severest frosts that ever happened with us, without any harm or prejudice at all; whereas one would think, that at least the extremities of their members should be bitten, benumbed and mortified thereby. Considering with myself by what means they were enabled to do this, and to abide and resist the cold, it occurred to my thoughts, that the extremities of their toes were fenced with hoofs, which in good measure secured them; but the main thing was, that the cold is, as it were

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its own antidote; for the air being fully charged and sated with nitrous, or some other sort of particles (which are the great efficient of cold, and no less also the *Pabulum* of fire) when inspired, doth by means of them cause a great accension and heat in the blood (as we see fuel burns rashly in such weather) and so enable it to resist the impressions of the cold for so short a time as its more nimble circulation exposes it thereto, before it comes to another heating. From hence may an account be given why the inhabitants of hot countries may endure longer fasting and hunger than those of colder; and those seemingly prodigious, and to us scarce credible stories, of the fastings and abstinence of the *Egyptian* monks, be rendered probable.

2. Other animals, which are of a colder temper, and made to endure a long *Inedia* or fasting, and to lie in their holes almost torpid all winter, as all kinds of *Serpents* and *Lizards*, have indeed lungs, but do not incessantly breathe, or when they have drawn in the air, necessarily expire it again, but can retain it at their pleasure, and live without respiration whole days together, as was long since experimented by Sir *Thomas Brown*, M.D. in a frog tyed by the foot under water for that purpose by him. This order of creatures have but one ventricle in their hearts, and the whole blood doth not so often circulate thro' the lungs as it doth thro' the rest of the body; this manner of breathing is sufficient to maintain in them that degree of heat which is suitable to their nature and manner of living; for to our touch they are always cold, even in summer-time, and therefore some will then put Snakes into their bosom to cool them.

3. Fishes, which were to live and converse always in a cold element, the water, and therefore were to have a temper not excelling in heat, because otherwise the constant immediate contact

of the water (unless some extraordinary provision were made) could not have been supported by them, that they might not be necessitated continually to be coming up to the top of the water to draw in the air, and for many other reasons that might be alledged, perform their respiration under water by the gills, by which they can receive no more air than is dispersed in the pores of the water, which is sufficient to preserve their bodies in that temper of heat that is suitable to their nature and the place wherein they live; these also have but one ventricle in their hearts.

But now tho' this be thus, the great and most wise GOD, as it were purposely to demonstrate that he is not by any condition or quality of place necessarily determined to one manner of respiration, or one temper of body in fishes, he hath endued the bodies of some of that tribe of aquatick creatures with lungs like viviparous quadrupeds, and two ventricles of the heart, and an ability of breathing like them, by drawing in and letting out the open air, so contriving their bodies as to maintain in the midst of the cold water a degree of heat answerable to that of the fore-mentioned quadrupeds.

Another remarkable thing relating to respiration is, the keeping the hole or passage between the *Arteria Venosa* and *Vena Cava*, called *Foramen ovale*, open in some amphibious quadrupeds, viz. the *Phoca*, or *Vitulus Marinus*, called in *English*, *Sea-calf* and *Seal*; and, as is generally held, the *Beaver* too. We have already given the reason of the twofold communication of the great blood-vessels in the *Fœtus* or young so long as it continues in the womb; the one between the two veins entring the heart, by a hole or window; the other between the two arteries, by an arterial channel extended from the pulmonary artery to the *Aorta*, or great artery; which was, in brief, to divert

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divert the blood from the lungs. The same reason for keeping open this *Foramen ovale* there is in these amphibious creatures, For, 1. The lungs probably being not extended, but emptied of air when they abide long under water, and flaccid, it is not easy for the whole blood every circulation to make its way thro' them. 2. To maintain that degree of heat and motion in the blood as is sufficient for them while they are under water, there is not so much air required as is when they are above, the blood then moving but gently, as doth that of the *Fœtus* in the womb.

Farther, in reference to respiration, it is observed by the *Parisian* Academists, that some amphibious quadrupeds, particularly the *Sea-calf* or *Seal*, hath his *Epiglottis* extraordinarily large in proportion to other animals, it extending half an inch in length beyond the *Glottis*, to cover it. I believe the *Beaver* hath the like *Epiglottis*, exactly closing the *Larynx* or *Glottis*, and hindring all influx of water; because in one dissected by *Wepferus*, that suffocated itself in the water, there was not a drop of water found in the lungs; it is probable (say they) that this is done more exactly to close the entrance of the *Aspera Arteria*, or wind-pipe, when the animal eats his prey at the bottom of the sea, and to hinder the water from running into his lungs. An Elephant (as is observed by Dr. *Moulins*, I think, in the anatomy of that creature) hath no *Epiglottis* at all, there being no danger of any thing falling into their lungs from eating or drinking, seeing there is no communication between the *Oesophagus* and it; for he thus describes the *Oesophagus* or gullet: The tongue of this creature (saith he) had this peculiar in it, that the passage to the ventricle was thro' it, for there was a hole near the root of it, and exactly in the middle of that part, which hole was the beginning of the *Oesophagus*; there was no

communication between this and the passage into the lungs, contrary to what we may observe in men, in all quadrupeds and fowl, that ever I had opportunity to dissect; for the *Membrana pituitaria anterior* reached to the very root of the tongue, below the *Oesophagus*, and so quite stopt the passage of the air into the mouth. But tho' there be no danger of meat or drink falling into the lungs, yet were they not sufficiently secured from small animals creeping in there; for tho', to supply in some measure the want of an *Epiglottis*, by lessening the *Glottis*, there grew to the outside of the cartilages called *Arytenoides*, another capable of motion up and down, by the help of some muscles that were implanted in it, strong on both sides of the *Aspera Arteria*, but on the under side, opposite to that of the *Oesophagus*, very limber, wanting about two inches and an half of coming round the foresaid cartilages on the upper side, or the next to the *Oesophagus*; yet did not this cartilage so shut up the way against them, but that even a *Mouse* creeping up his *Proboscis* might get into his lungs, and so stifle him; whence we may guess at the reason why the *Elephant* is afraid of a *Mouse*; and therefore to avoid this danger, this creature (the *Elephant*, which this author described) was observed always when he slept to keep his trunk (*Proboscis*) so close to the ground that nothing but air could get in between them; this is a strange sagacity and providence in this animal, or else an admirable instinct.

Again, the *Parisian* Academists observe of the *Sea Tortoise*, that the cleft of the *Glottis* was strait and close; which exact inclosure I do rather believe is to prevent the water from entring into the wind-pipe when the *Tortoises* are under water, than to assist the effect of the compression of the air in the lungs, as they would have it; for they make the main reason of respiration and use of the

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the lungs in this creature to be, to take in and retain air, by the compression and dilatation whereof, made by the muscles, it can raise or sink itself in the water, as need requires; though I do not exclude this. But if this be the main use of the lungs and respiration in this animal, what is it in land animals, which have a like conformation of lungs and manner of respiration as the *Camelion, Serpents, and Lizards*?

But before I dismiss the *Tortoise*, I shall add two notable observations concerning him, borrowed of the said *French Academists*, which seem to argue something of reason in him, and more than a bare instinct. The first is in the *Land Tortoise*; and it is his manner of turning himself, and getting upon his feet again when he is cast upon his back, which they describe in these words: *At the great aperture of the shell before, there was at the top a raised border, to grant more liberty to the neck and head, for lifting themselves upwards; and this inflection of the neck is of great use to the tortoises, for it serves them to turn again when they are upon their backs; and their industry upon this account is very admirable. We have observed in a living Tortoise, that being turned upon its back, and not being able to make use of its paws for the returning of itself, because they could but only bend towards the belly, it could help itself only by its neck and head, which it turned sometimes on one side, sometimes on the other, by pushing against the ground, to rock itself as in a cradle, to find out the side towards which the inequality of the ground might more easily permit it to rowl its shell; for when it had found it, it made all its endeavours on that side.*

The second is in the *Sea Tortoise*, as follows. *Aristotle and Pliny* have remarked, that when *Tortoises* have been a long time upon the water during a calm, it happens that their shell being dried in the sun, they are easily taken by the fishermen, by reason



reason they cannot plunge into the water nimbly enough, being become too light; this shews what equality there ought to be in their *Æquilibrium*, seeing so little a change as this; which may happen by the sole drying of the shell, is capable of making it useless. This easiness to be taken at such a time, these *Academists* do not refer merely to the lightness of this creature's body (for he could easily let air enough out of his lungs to render it heavier than the water, and so enable himself to sink) but to a wonderful sagacity and caution of this animal; for (say they) it is probable that the *Tortoise*, which is always careful to keep himself in this *Æquilibrium*; so as other animals are to keep themselves on their legs, in this case, by the same instinct, dares not let the air out of his lungs, to acquire a weight which might make him speedily to sink, because he fears that his shell being wet it should become so heavy, that he being sunk to the bottom of the water, might never have power afterwards to re-ascend; if this may be the reason why he exposes himself to the danger of being taken at such a time, rather than he will descend suddenly to the bottom, it is clear that he is endued with an admirable providence and foresight, and a power of argumentation.

That nature doth really design the preservation and security of the more infirm creatures, by the defensive armour that it hath given to some of them, together with skill to use it, is, I think, demonstrable in the common *Hedge-hog* or *Urchin*, and one species of *Tatou*, or *Armadillo*. The *Hedge-hog* hath his back, sides and flanks thick set with strong and sharp prickles, and besides, by the help of a muscle given him for that purpose is enabled to contract himself into a globular figure, and so to withdraw, inclose, and hide his whole underpart, head, belly and legs (which for the necessities and conveniencies of life must be left de-

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stitute of this armour) within his cover or thicket of prickles; so that dogs, or other rapacious creatures, cannot lay hold upon him or bite him without wounding their own noses and mouths. The muscle whereby he is enabled to draw himself thus together, and gather up his whole body like a ball, the *Parisian Academists* describe to be a distinct carnosè muscle, extended from the *Ossa innominata* to the ear and nose, running along the back-bone, without being fastened thereto. *Olaus Borrichius* in the *Danick transactions*, makes it to be an almost circular muscle, embracing the *Panniculus carnosus*, of a wonderful fabrick, variously extending its *Laciniæ*, or processes, to the feet, tail, and head of the creature.

The other creature which doth thus contract and draw up itself into a globular or oval figure for its defence, is the second sort of *Tatou*, or *Armadillo*, largely described by *Marcgrave*, lib. 6. cap. 9. by the name of *Tatu Apará*, which is covered on its back and its sides with a strong scaly crust or shell, of a hard or boney substance, jointed like armour, or the scales of the tail of a lobster, by four transverse commissures in the middle of the body, connected by tough membranes. When it sleeps (as it doth for the most part in the daytime, going forth to feed in the night) or when one goes about to lay hold on it, gathering up its fore and hind legs as it were to one point, and drawing up its ears with its head inward, and bringing its tail to its head by reason of the fore-mentioned commissures, it bends its back so far till its head comes to touch its hind part, and so with armour gather itself into a round ball, the lateral extremities of the shell touching one another, and inclosing the body on the sides, and the fore and hind parts coming so near together, that there is nothing to be seen but the armature of the head and tail, which, like doors, shut up the hole which the shells of the

the body left open; this it performs by the action of a notable muscle on each side, of a great length having the form of the letter X, made up of many fibres, decussating one another long-ways, by the help whereof it can contract its shell, and hold it contracted with such a mighty force, that he must be a strong man indeed that is able to open it.

Had such a muscle as this, and such an ability of contraction, been given to any creature that was covered with soft hair or fur, there might have been some pretence to fancy that this was accidental, and not designed; but seeing there is not one instance of this kind in nature, it must be great stupidity to believe it, and an impudence to ascribe it; neither will the Atheists usual *αποφύγιστον*, or refuge, *that there were indeed at first such creatures produced, but being obnoxious to those that were strong and rapacious, yet they were by degrees destroyed, and the race lost*, here help them out; because such a muscle, and faculty of using it to that purpose, might as likely have fallen to the lot of chance of a strong and generous creature, which others dared not approach to hurt, who might for his own disport have thus contracted himself into a ball, of which kind we find none.

I have before-mentioned the use assigned by the honourable Mr. Boyle, of famous memory, lately deceased, to the *Periophthalmium*, or nectating membrane in brutes, wherein I could not fully acquiesce as to some quadrupeds, which were in no danger of having their eyes harmed by bushes and prickles, or twigs of trees; since the writing whereof I have met with a different account of the use of that membrane, in the *Anatomical description of several creatures dissected* by the Royal Academy of sciences at Paris, englished by Mr. Alexander Pitfield, p. 249. in the description of the *Cassowary*. Our opinion (say those Academists) is, that the membrane serves to clean the

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the action of the eye, and to hinder, that by drying, it grow no less transparent. Man and the Ape, which are the sole animals wherein we have not found this eye lid, have not wanted this provision for the cleansing of their eyes because that they have hands, with which they may, by rubbing their eye-lids, express the humidity which they contain, and which they let out through the *Ductus Lachrymalis*; which is known by experience, when the sight is darkened, or when the eyes suffer any pain or itching; for these accidents do cease when the eyes are rubbed.

But the dissection has distinctly discovered to us the organs which do particularly serve for this use, and which are otherwise in birds than in man, where the *Ductus* passes not beyond the *Glandula Lachrymalis*; for in birds it goes beyond, and penetrating above half way on the internal eye-lid, it is opened underneath upon the eye; which is evidently done to spread a liquor over the whole *Cornea*, when the eye-lid passes and repasses, as we observe it to do every moment.

The artifice and contrivance of nature for the extending and withdrawing of this curtain of the *Periophthalmium* in birds is admirable; but it is difficult so to express it, in words as to render it intelligible to the reader; for a multitude of words doth rather obscure than illustrate, they being a burden to the memory, and the first apt to be forgotten before we come to the last; so that he that uses many words for the explaining any subject, doth, like the *Cuttle-Fish*, hide himself for the most part in his own ink; and in the description of the figure and manner of the extension and contraction of this membrane, the *Parisian Academists* are constrained to use so many words, that I am afraid few readers patience and attention will last so long as to comprehend and carry it away; yet because it is so evident and irrefragable a proof of wisdom

wisdom and design, I could not omit it; their words are these: The particularities of the admirable structure of this eye-lid are such things as do distinctly discover the wisdom of nature among a thousand others, of which we perceive not the contrivance, because we understand them only by the effects, of which we know not the causes; but we here treat of a machine, all the parts whereof are visible, and which need only to be looked upon to discover the reason of its motion and action.

This internal eye-lid in birds is a membranous part, which is extended over the *Cornea* when it is drawn upon it like a curtain by a little cord or tendon, and which is drawn back again into the great corner of the eye, to uncover the *Cornea* by the means of the very strong ligaments that it has, and which in drawing it back towards its origin do fold it up; it made a triangle when extended, and it had the figure of a crescent when folded up; its *Basis* (which is its origin) was toward the great corner of the eye, at the edge of the great circle, which the *Sclerotica* forms when it is flated before, making an angle with its anterior part, that is, the *Cornea*, which is raised like a hill upon it; the *Basis*, which is the part immoveable, and fastened to the edge of the *Sclerotica*, did take up more than a third part of the circumference of the great circle of the *Sclerotica*; the side of the triangle, which is toward the little corner of the eye, and is moveable, was reinforced with a border, which supplies the place of the *Tarsus*, and which is black in most quadrupeds; this side of the eye-lid is that which is drawn back into the corner of the eye, by the action of the fibres of the whole eye-lid, which parting from its origin, proceed to join themselves to its *Tarsus*.

To extend this eye-lid over the *Cornea*, there were two muscles that were seen, when six were taken away, which served to the motion of the whole

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whole eye; we found that the greatest of these two muscles has its origin at the very edge of the great circle of the *Sclerotica*, towards the great corner, from whence the eye-lid takes its original; it is very fleshy in its beginning, which is a large *Basis*, from whence coming insensibly to contract itself by passing under the globe of the eye, like as the eye-lid passes over it, it approaches the optick nerve, where it produces a tendon round and slender, so that it passes thro' the tendon of the other muscle, which serves for a pulley, and which hinders it from pressing the optick nerve, upon which it is bent, and making an angle, to pass thro' it to the upper part of the eye, and coming out from underneath the eye to insert itself at the corner of the membrane which makes the internal eye-lid; this second muscle hath its original at the same circle of the *Sclerotica*, but opposite to the first towards the little corner of the eye, and passing under the eye like the other, goes to meet it, and embraces its tendon, as has been declared.

The action of these two muscles is, in respect to the first, to draw, by the means of its cord or tendon, the corner of the internal eye-lid, and to extend it over the *Cornea*; as to the second muscle, its action is, by making its tendon to approach towards its origin, to hinder the cord of the first muscle, which it embraces, from hurting the optick nerve; but its principal use is to assist the action of the first muscle; and it is herein that the mechanism is marvellous in this structure, which makes that these two muscles join'd together do draw much farther than if it had but one; for the inflection of the cord of the first muscle, which causes it to make an angle on the optick nerve, is made only for this end; and a single muscle with a strait tendon had been sufficient, if it had power to draw far enough; but the trac-



tation which must make the eye-lid extend over the whole *Cornea* being necessarily great, it could not be done but by a very long muscle, and such a muscle not being able to be lodged in the eye all its length, there was no better way to supply the action of a long muscle than by that of two indifferent ones, and by bending one of them to give it the greater length in a little space. Thus far the *Academists*, who themselves reflecting on the length and obscurity of this description, tell us, that the inspection of the figure will serve greatly to the understanding of it, which the novelty of the thing renders obscure in itself, and so I fear it will be to most readers; howbeit, in such a work as this I ought not by any means, as I said before to leave out such a notable instance, wherein contrivance and design do so clearly and undeniably appear.

The same *Academists*, as I remember, tell us, that they have found by experience that the aqueous humour of the eye will not freeze; which is very admirable, seeing it hath the perspicuity and fluidity of common water, and hath not been taken notice of, so far as I have heard, to have any eminent quality discoverable either by taste or smell; so that it must be of some singular and aethereal nature, and deserves to be examined and annalized by the curious naturalists of our times.

The providence of nature is wonderful in a *Camel* or *Dromedary*, both in the structure of his body, and in the provision that is made for the sustenance of it; concerning the first I shall instance only in the make of his foot, the sole whereof, as the *Parisian Academists* do observe, is flat and broad, being very fleshy, and covered only with a thick, soft, and somewhat callous skin, but very fit and proper to travel in sandy places, such as are the desarts of *Africa* and *Asia*; we thought (say they) that this skin was like a living sole, which

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which wore not with the swiftness and the continuance of the march, for which this animal is almost indefatigable; and it may be this softness of the foot, which yields and fits itself to the ruggedness and unevenness of the roads, does render the feet less capable of being worn than if they were more solid.

As to the second, the provision that is made for their sustenance in their continued travels over sandy deserts, the same Academists observe, that at the top of the second ventricle (for they are ruminant creatures, and have four stomachs) there were several square holes, which were the orifices of about twenty cavities, made like sacks, placed between the two membranes which do compose the substance of this ventricle; the view of these sacks made us to think that they might well be the reservators, where *Pliny* says that Camels do a long time keep the water, which they drink in great abundance when they meet with it, to supply the wants which they may have hereof in the dry deserts wherein they are used to travel, and where it is said that those that do guide them are sometimes forced, by extremity of thirst, to open their bellies, in which they do find water.

That such an animal as this, so patient of long thirst, should be bred in such drouthy and parched countries, where it is of such eminent use for travelling over those dry and sandy deserts, where no water is to be had sometimes in two or three days journey, no candid and considerate person but must needs acknowledge to be an effect of providence and design.

Such animals as feed naturally upon flesh, both quadrupeds and birds, because such kind of food is high and rank, do qualify it, the one by swallowing the hair or fur of the beasts they prey upon, the other by devouring some part of the feathers of the birds they gorge themselves with, not electively,

but because they cannot or will not take the pains fully to plume them; and therefore the *Parisian Academists* do rationally refer the death of one of the lions whom they dissected, to the feeding of him with too succulent and delicate meat; for (say they) we know that some time before his death he was several months without going out of his den, and that it was hard to make him eat; that for this reason some remedies were prescribed to him, and among others the eating only the flesh of young animals, and those alive; and that those which looked to the beasts of the park of *Vicennes*, to make this food more delicate, did use a method very extraordinary; which was, they flead lambs alive, and thus made him eat several; which at the first revived him, creating in him an appetite, and making him brisk; but it is probable that this food engendered too much blood, and which was too subtil for an animal to whom nature had not given the industry of fleaing those which he eat; it being credible that the hair, wool, feathers, and scales, which all animals of prey do swallow, are a seasonable and necessary corrective, to prevent their greediness from filling themselves with too succulent a food.

Tho' I have declared in the beginning of this work that the means whereby cartilaginous fishes raise and sink themselves in the water, and rest and abide in what depth they please, is not yet certainly known, yet I shall propound a conjecture concerning it, which was first suggested to me by *Mr. Peter Dent*, late physician in *Cambridge*, viz. that it is by the help of water which they take in and let out by two holes in the lower part of their *Abdomen* or belly, near the vent, or not far off it; the flesh of this sort of fish being lax and spongy, and nothing so firm, solid and weighty as that of the boney fishes, and there being a good quantity of air contained in the cavity of their

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*Abdomen*, they cannot sink in the water without letting in some of it by these holes (the orifices whereof are opened and shut at pleasure by the help of muscles provided for that purpose) into the hollow of their bellies, whereby they preponderate the water, and descend; and when they would ascend, by a compression wrought by the muscles of the *Abdomen*, they force out the water again, or at least so much of it as may suffice to give that degree of levity they need or desire; if it be found by experience that the bodies of these fishes without this ballast would naturally float in the water, and that they do really admit water into their bellies, then this conjecture may have some probability or truth in it, otherwise not.

Upon the contemplation and consideration of those various ways and contrivances which nature (I mean the divine wisdom) hath made use of for preparing the chyle, separating the nutritious juice from the grosser parts of the aliment, and the several humours and spirits from the blood, I cannot but admire her great wisdom, art and curiosity; for she hath not only employed all those methods and devices which chymists have either learned by imitation of her, or invented of themselves, for annalizing of bodies, separating their parts, the pure from impure, and extracting their spirits, &c. as *Maceration* in the first stomach or paunch of ruminating creatures, and in the craws of birds; *Comminution*, by grinding in the mouths of viviparous quadrupeds, and in the gizzards of poultry; *Fermentation* in the stomachs of most terrestrial, and all aquatick animals; *Expression* and squeezing in the *Omasus* of ruminant quadrupeds, and in the intestines of all creatures, by the motion of the midriff and other muscles of the belly, forcing the chyle out of the *Fæces* or excrements into the lacteal veins; *Straining* or *Percolation* by all the *Viscera* of the body, which are but as so

many colanders to separate several juices from the blood; and lastly, *Digestion* and *Circulation* in the spermatick parts and vessels, and perhaps also in the brain; I say, it hath not only made use of these operations, but it hath quite out-done the chymists, effecting that by a gentle heat which they cannot perform without great streſs of fire; as for instance, in the stomach of a dog, preparing a liquor that dissolves bones; and in the bodies of some insects, a liquor which seems to be as highly acid and corrosive as oil of vitriol or spirit of nitre, viz. that which is instilled into the blood when they sting; it is an experiment I have met with in some books, and made myself, that if you put blue bottles, or other blue flowers into an ant-hill, they will presently be stained with red; the reason (which these authors render not) is, because the ants thrust in their stings into the flowers, and instil into or drop upon them a small mite of their stinging liquor, which hath the same effect that oil of vitriol would have in changing their colour, which is a sign that both liquors are of the same nature.

*Casper Bartholine* hath observed, that where the gullet perforates the midriff, the carneous fibres of that muscular part are inflected and arcuate, as it were a *Spincter* embracing and closing it fast, by a great providence of nature, lest in the perpetual motion of the diaphragm the upper orifice of the stomach should gape, and cast out the victuals as fast as it received it; and *Peyerus* thinks he hath observed, that in ruminating creatures the connection of the gullet with the diaphragm is far straiter and stronger than in man and other animals, to the end that there should not be more than one morsel forced out at once; for that external sphincter inhibits a too great dilatation of the gullet, and doth as it were measure out the morsels, and fit them to the capacity of the *Oesophagus*.

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I shall conclude with a notable relation of *Galen's, Lib. 6. de locis effectis, cap. 6.* concerning a kid taken by him alive out of the dam's belly, and nourished and brought up.

Ἡ διαπλάσασά τε ἔτι τελευτάσασα φύσις ἐργάσατο χάρις διδασκαλίας ἐπὶ οἰκείῳ ἐνέργησαν ἐρχισθαι· ἔβασανόν γε τύτῃ μεγίστην ἰποικασάμην ποτὶ θρίψας ἱριφον, ἀνιὺ τῷ διασασθαι ποτε τὴν κησάσαν· αἶγας γὰρ ἐγκύμοντας ἀνατεμών· ἔνεκα τῶν ἐζητημένων διωρημάτων τοῖς ἀνατομικοῖς ἀνδράσι περὶ τῆς κατὰ τὸ κύμεινον οἰκονομίας, ἱυρῶ ποτὶ γενναῖον τὸ ἐμβρυον ἀπέλυσα· μὲν τῆς μητρὸς ὥσπερ ἐώδαμην ἀρπάσας δὲ πρὶν διασασθαι τὴν κησάσαν εἰς οἶκον μὲν τινα κομίσας κατέδηκα, πολλὰ μὲν ἔχοντα λευκάνια· τὸ μὲν οἶνον, τὸ δὲ ἑλαῖν, τὸ δὲ μέλιτος, τὸ δὲ γαλακτός, ἢ ἄλλῃ τινὸς ὑγρῷ πλήρεις, οὐκ ὀλίγας· ἢ ἄλλα τῶν Δημητρίων καρπῶν, ὥσπερ δὲ ἔτι τῶν ἀκροδρύων ἱδιασάμεθα δὲ τὸ ἐμβρυον ἐκέννο, πρῶτον μὲν βαδίζον τοῖς ποσίν, ὥσπερ ἀκηκοῦς ἔνεκα βαδίστιος ἔχεν τὰ σκέλη· διυτίρον δὲ ἀποσπείοντες τὴν ἐκ τῆς μητρὸς ὑγρότητα, ἔτι τρίτον ἐπὶ τύτῃ κησάμενον ἐν τῶν ποδῶν τὴν πλευράν, ἢ τ' ὁσμώμενον· ἔδομεν αὐτὸ τῶν κειμένων κατὰ τὸν οἶκον ἐκάσθῃ, ὥς δὲ πάντων ὁσμῶν τῷ γάλακτος ἀπιδόρῃσιν ἐν ᾧ ἔτι ἀνεκράγαμεν ἀκάντες, ἐναργῶς ὁρῶντες ὅπερ Ἰπποκράτης ἔφη φύσεις ζῶων ἀδιδασκτοῖς· καὶ τοῖνον ἔτι ἀνιθριψάμην ἐκέννο τὸ ἱριφον ἔδομεν τε προσφερόμενην ὑστέρῃ ἢ τὸ γάλακτος, ἀλλὰ ἔτι ἀλλὰ τινὰ τῶν κειμένων· ὄντος δὲ τῷ καιρῷ καθ' ὃν ἐξηρίθη τῆς μητρὸς ὁ ἱριφας, ἰγγὺς τῆς ἐσπριῆς ἰσημερίας, μετὰ δύο πῦ μῆνας εἰσεκομίσασθαι αὐτῷ μαλακῶς ἀκρέμονας θάμναν τε ἔτι φυτῶν, ὧν πάλιν ἔτι αὐτῶν ὁσμωσάμενον ἀπάντων, ἰνίον μὲν εὐθιῶς ἀπίση τῶν δὲ ἡζιώως γιγνέσθαι, ἔτι γινεσθαι ἐν τῇ ἰδωδῇ ἐτράπετο τῶν ἔτι ταῖς μεγάλαις αἰζῇ συνήθων ἰδεσμάτων· Ἀλλὰ τῷτο μὲν ἴσως μικρὸν ἐκέννο δὲ μέγα τὰ καρ. φύλλα ἔτι τὸς μαλακῶς ἀκρέμονας ἀποφάγων κατέπιεν· εἴτ' ὀλίγον ὑστέρῃ ἐπὶ τὸ μηρυκάζον ἦκεν, ὃ τάχιν διασάμενοι πάντες ἀνέβησαν ἀκπλαγνίτες ἐπὶ ταῖς τῶν ζῶων δυνάμεισι· μέγα μὲν γὰρ ἦ ἔτι τὸ πυνῆσαν διὰ τε τῷ σώματος ἔτι τῶν ὀδόντων προσφίρεσθαι τὴν ἰδωδῇ· ἀλλ' ὅτε τὸ καταποθὲν εἰς τὴν γαστέρα, πρῶτον μὲν ἀναφύειν εἰς τὸ σῶμα προσήκειν, ἔπειτα λαίανεν ἐν αὐτῷ μασσόμενον ἐν χρόνῳ πολλῷ, ἔτι μετὰ ταῦτα καταπίνην· μεκίτι εἰς τὴν ἀτὴν κοιλίαν, ἀλλ' εἰς ἑτέραν ἰκανῶς ἡμῖν ἰφαίνεται θαυμάσιον ἵναί. Παρορῶσι δὲ πολλοὶ τὰ τοιαῦτα τῆς φύσεως ἔργα, μόνῃ τῇ ξίνα διαμάκατα θαυμάζοντες.

That is to say,

Nature



Nature forming, fashioning, and perfecting the parts of the body, hath so brought it to pass, that they should of themselves, without any teaching, set about and perform their proper actions; and of this I once made a great experiment, bringing up a kid without ever seeing its dam; for dissecting some goats great with young, to resolve some questions made by Anatomists concerning the œconomy of nature in the formation of the Foetus in the womb, and finding a brisk Embryon [young one] I loos'd it from the Matrix after our usual manner, and snatching it away before it saw its dam, I brought it into a certain room, having many vessels full, some of wine, some of oil, some of honey, some of milk, or some other liquor; and others, not a few, filled with all sorts of grain, as also with several fruits, and there laid it. This Embryon we saw first of all getting up on its feet and walking, as if it had heard that its legs were given it for that purpose; next shaking off the slime it was besmeared with from the womb; and moreover, thirdly, scratching its side with one of its feet; then we saw it smelling to every one of those things that were set in the room; and when it had smelt to them all, it sucked up the milk; whereupon we all for admiration cryed out, seeing clearly the truth of what Hippocrates saith, that the natures and actions of animals are not taught (but by instinct.) Hereupon I nourished and reared this Kid, and observed it afterwards not only to eat milk, but some other things that stood by it. And the time when this Kid was taken out of the womb being about the vernal equinox, after some two months, were brought into it the tender sprouts of shrubs and plants, and it again smelling of all of them, instantly refused some, but was pleased to taste others; and after it had tasted, began to eat of such as are the usual food of goats. Perchance this may seem a small thing, but what I shall now relate

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late is great; for eating the leaves and tender sprouts, it swallowed them down, and then a while after it began to chew the cud, which all that saw cried out again with admiration, being astonished at the instincts and natural faculties of animals; for it was a great thing that when the creature was hungry it should take in the food by the mouth, and chew it with its teeth; but that it should bring up again into the mouth that which it had swallowed down into its first stomach, and chewing it there a long time, it should grind and smooth it, afterwards swallow it again, not into the same stomach, but into another, seemed to us wonderful indeed. But many neglect such works of nature, admiring only strange and unusual sights. So far Galen..

This pleasant and admirable story, should one consider all the particulars of it, and endeavour to give an account of them, as also all the inferences that might be drawn from it, one might fill a whole volume with comments upon it. All that I shall at present say is this, That in all this oeconomy, and these actions, council and design doth so clearly appear, that he must needs be very stupid that doth not discern it, or impudent that can deny it. I might add, that there seems to be something more than can be performed by mere mechanism in the election this creature made of its food; for before it would eat of any, it smelled to all the liquors before it, and when it had done so, betook itself to the milk, and devoured that; he doth not say that the milk was the last liquor it smelled to, or that when it had once smelled to that, it presently drank it up. The like also he saith of all the sprouts and branches of plants that were laid before it. By the by we may take notice of one thing very remarkable, that this Kid of its own accord drank milk after the manner it had done in the late

the womb; whereas had it once drawn by the nipple, it would hardly have supped the milk; and therefore in weaning young creatures the best way is never to let them suck the paps at all, for then they will drink up milk without any difficulty; whereas if they have sucked, some will very hardly others by no means be brought to drink: but how do the young with such facility come to take the nipple, and to suck at it, which they had never before used to do? Here we must have recourse to natural instinct, and the direction of some superior cause.

Notice hath been already taken in an observation communicated by my learned friend Dr. *Tacred Robinson*, of the providence of nature in forming the membranes of the body as to be capable of a prodigious dilatation and extension, which is of great use in some diseases; for example, the dropsy, to continue life for some time till remedy may be had; and if not, to give time to prepare for death: but the wisdom and design of this texture doth in no instance more clearly appear, than in the necessity of it for the womb at the time of gestation; for were not the womb of women, which during virginity is not bigger than a small purse, almost indefinitely dilatable, and also the *Peritoneum*, not to mention the skin and the *Curticula*, how were it possible it should contain the child, nay, sometimes twins, with all the appurtenances, the secundines, the *Placenta*, liquor or waters, and what else is necessary for the defence, nutrition, respiration, and soft and convenient lodging of them, till they come to their due perfection and maturity for exclusion? How could the child have room to grow there in his bigness, and stir and turn himself, as is requisite? Add hereto another observation of *Blasius* particularly relating to this subject; he hath observed that the vessels of the interior glandular

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Another remarkable proof of counsel and design may be fetched from the formation of the veins and arteries near the heart, which I meet with in Dr. Lower's treatise, *de Corde*. Just before the entrance of the right auricle of the heart (saith he) to it, where the ascending trunk of the *Vena Cava* meeting with the descending, is ready to empty itself into the said right auricle, there occurs in it a very remarkable knob or bunch [*Tuberculum*] raised up from the subjacent fat, by the interposition whereof the blood falling down by the descending vein is diverted in the auricle, which otherwise encountering and bearing upon that of the ascendent trunk, would very much hinder and retard the motion of it upward towards the heart; and because in an erect site and figure of the body there is a great and more imminent danger of such an accident, therefore the *Vena Cava* in mankind hath this tubercle far greater and of more extent than it is in brutes; so that if you thrust your finger into either trunk, you can hardly find passage or admittance into the other.

But in quadrupeds as in *Sheep, Dogs, Horse, Kine*, in which the course of the blood from either extreme of the body is more equal, and as it were in a plainer level; and because the heart by reason of its bulk and weight hanging downwards, both trunks of the *Vena Cava* have some little declivity towards it, there is no need of so great a bar and diversity in them, yet are they not altogether devoid of it.

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Moreover, lest the blood here in its conflux should make a kind of flood and whirlpool, whilst the auricle being contracted doth not give it free ingress, therefore in this place the *Vena Cava* in great animals, as well man as quadrupeds, is round about musculous, as well that it may be restrained and kept within its due limits of extension, as that it may more vigorously and strongly urge and impel the blood into the cavity of the auricle.

Besides, there is no less providence and caution used that the blood, when it is forcibly cast out of the left ventricle of the heart, be not unequally distributed to the superior and inferior parts; for whereas this gate or orifice of the heart opens right upwards, if that channel which receives the first impulse of the blood did lead in a strait line up to the region of the head, it could not be but that it must be poured too swiftly upon the brain, and so the inferior parts of the body must needs be defrauded of their vital liquor and aliment; which inconvenience, that the divine Architect of the body might wholly obviate and avoid in animals, whose hearts are more strongly moved, he so artificially, contrived the trunk of the *Aorta*, which is next the heart, that the blood runs not directly into the axillary and carotid arteries, but doth as it were fetch a compass; for in the middle space between the ventricle and those arteries it is very much inflected or bent: whence it comes to pass that that crooked angle sustains the force and first stroke of the ejected blood, and directs the greatest torrent of it towards the descending trunk of the *Aorta*, which otherwise would rush too forcibly into the superior branches thereof, distending them immoderately, and soon oppress and burden the Head. *So far Dr. Lower.*

To elude or evade the force of all these instances, and innumerable others which might be produced

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duced, to demonstrate that the bodies of men and all other animals were the effects of the wisdom and power of an intelligent and Almighty Agent, and the several parts and members of them designed to the uses to which now they serve, the *Atheist* hath one subterfuge, in which he most confides, viz. that all these uses of parts are no more than what is necessary to the very existence of the things to whom they belong, and that things make uses, and not uses things.

——— *Nil ideo natum est in corpore ut uti Possimus, sed quod natum est id procreat usum.*  
Saith *Lucretius*, Lib. 4.

And having instanced in several members, he concludes,

——— *Omnia denique membra Ante fuere, ut opinor, eorum quam fuit usus.*

I shall give you their sense, together with the confutation of it, in Dr. *Bentley's* words, borrowed out of his fifth lecture, &c.

These things (say \* they) are mistaken for tokens of skill and contrivance, whereas they are but necessary consequences of the present existence of those creatures to which they belong; for he that supposeth any animals to subsist, doth by that very supposition allow them every member and faculty that are necessary to subsistence; and therefore unless we can prove *a priori*, and independent on this usefulness, now that things are once supposed to have existed and propagated, that among almost infinite trials and essays at the beginning of things, among millions of monstrous shapes and imperfect formations, a few such animals as now exist could not possibly be produced, these after-considerations



are of very little moment; because if such animals could in that way *possibly* be formed, as might live and move, and propagate their beings, all this admired and applauded usefulness of their several fabrics is but a necessary condition and consequence of their existence and propagation.

This is the last pretence and sophistry of the *Atheists* against the proposition in my text [*Acts* xvii. 27.] that we received our life and being from a Divine Wisdom and Power; and as they cannot justly accuse me of concealing or baulking their grand objection, so I believe these following considerations will give them no reason to boast that it cannot receive a just and satisfactory answer.

(1.) *First*, therefore, we affirm that we can prove, and have done it already by arguments *a priori* (which is the challenge of the *Atheists*) that these animals that now exist could not possibly have been formed at first by millions of trials; for (seeing they allow by their very *Hypothesis* (and without standing to that courtesy we have proved it before) that there can be no casual or spontaneous motion of the particles of matter, it will follow, that every single monster, among so many supposed myriads, must have been mechanically and necessarily formed, according to the known laws of motion, and the temperament and quality of the matter it was made of, which is sufficient that no such monsters were or could have been formed; for to denominate them even monsters they must have had some rude kind of organical bodies, some *stamina* of life, tho' never so clumsy, some *system* of parts, compounded of solids and liquids, that executed (tho' but bunglingly) their peculiar motions and functions. But we have lately shewn it impossible for nature unassisted to constitute such bodies, whose structure is against the law of specific gravity; so that she could not make the least endeavour towards the producing of a monster.

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or of any thing that hath more vital and organical parts than we find in a rock of marble or a fountain of water. And again, tho' we should not contend with them about their monsters and abortions, yet seeing that they suppose even the perfect animals that are still in being to have been formed mechanically among the rest, and only add some millions of monsters to the reckoning, they are liable to all the difficulties in the former explication, and are expressly refuted thro' the whole preceding *sermon*, where it is abundantly shewn that a spontaneous production is against the catholick laws of motion, and against matter of fact, a thing without example, not only in man and the nobler animals, but in the smallest of insects and the vilest of weeds; tho' the fertility of the earth cannot be said to have been impaired since the beginning of the world.

(2.) *Secondly*, We may observe that this evasion of the *Atheist* is fitted only to elude such arguments of divine wisdom as are taken from things necessary to the conservation of the animal, as the faculties of sight, and motion, and nutrition, and the like, because such usefulness is indeed included in a general supposition of the existence of that animal; but it miserably fails him against other reasons, from such members and powers of the body as are not necessary absolutely to living and propagating, but only much conduce to our better subsistence and happier condition. So the most obvious contemplation of the frame of our bodies, as that we all have double *Sensories*, two eyes, two ears, two nostrils, is an effectual confutation of this atheistical sophism; for a double organ of these senses is not at all comprehended in the notion of bare existence, one of them being sufficient to have preserved life and continued the species, as common experience witnesseth. Nay, even the very nails of our fingers are an infallible

token of design and contrivance, for they are useful and convenient, to give strength and firmness to those parts in the various functions they are put to, and to defend the numerous nerves and tendons that are under them, which have a most exquisite sense of pain, and without that native armour would continually be exposed to it; it is manifest therefore that there was a contrivance and foresight of the usefulness of nails antecedent to their formation; for the old stale pretence of the *Atheists*, that things were first made fortuitously, and afterwards their usefulness was observed or discovered, can have no place here, unless nails were either absolutely requisite to the existence of mankind, or were found only in some individuals or some nations of men; and so might be ascribed to necessity upon one account, or to fortune upon another. But from the *Atheists* supposition, that among the infinite diversity of the first terrestrial productions, there were animals of all imaginable shapes and structures of body, all of which survived and multiplied, that by reason of their make and fabrick could possibly do so, it necessarily follows that we should now have some nations without nails upon their fingers, others with one eye only, as the poets describe the *Cyclops* in *Sicily*, and the *Arimasphi* in *Scythia*; others with one ear, or with one nostril, or indeed without any organ of smelling, because that sense is not necessary to man's subsistence; others destitute of the use of language, seeing that mutes also may live. One people would have the feet of goats, as the feigned *Satyrs* and *Panisci*; another would resemble the head of *Jupiter Ammon*, or the horned statues of *Bacchus*; the *Sciopedes* and *Enotocetæ*, and other monstrous nations, would be no longer fables, but real instances in nature; and in a word, all the ridiculous and extravagant shapes that can be imagined, all the fancies and whimsies of poets and painters,

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painters, and *Egyptian* idolaters, if so be they are consistent with life and propagation, would be now actually in being if our *Atheists* notion were true; which therefore may deservedly pass for a mere dream and an error, till they please to make new discoveries in the *Terra incognita*, and bring along with them some savages of all these fabulous and monstrous configurations. Thus far Dr. Bentley: Who adds four considerations more to confute this fancy, *ex abundanti*, granting the *Atheist* all the absurd suppositions he can make; for which, tho' they be very well worth the reading, yet being too long to transcribe, I refer the reader to the *sermon* itself.

I shall now farther prove by a notable instance that uses made things, that is to say, that some things were made designedly and on purpose for such an use as they serve to; and that is, the tendrils or clasps of plants, because they are given only to such species as have weak and infirm stalks, and cannot rise up to support themselves by their own strength; we see not so much as one tree, or shrub, or herb, that hath a firm and strong stem, and that is able to mount up and stand alone without assistance, furnished with them: whereas had they been without design scattered (as I may say) indifferently and carelessly among plants, it could not possibly have happened but among so many thousand *species* they must have fallen to the lot of some few at least, some one of the strong, and not only of the weak; the same hath been proved by the instance of the power given to the *Hedge-hog* and *Armadillo*, of contracting their bodies into a globular figure, and so hiding and securing their tender and unarmed parts.

2. I shall prove by another eminent instance that things did not make uses, because there is a sort of creatures which have all the parts and organs which are fitted for a certain action, and employed

for the exercise of it by another sort, and yet make no use of them for that purpose; that is, the *Ape-kind*; the *Parisian Academists* in their anatomy of some animals of this kind tell us, that the muscles of the *Os Hyoidis*, *Tongue*, *Larynx* and *Pharynx*, which do most serve to articulate a word, were wholly like to those of *Man*, and a great deal more than those of the *Hand*, which nevertheless the *Ape*, which speaks not, uses with as much perfection as a man; which demonstrates that speech is an action more peculiar to man, and which more distinguishes him from brutes than the *Hands*, which *Anaxagoras*, *Aristotle* and *Galen* have thought to be the organ which nature has given to man as to the wisest of all animals, for want perhaps of this reflection; for the *Ape* is found provided by nature of all those marvellous organs of speech with so much exactness, that the very three small muscles which do take their rise from the *Apothesis Styloides* are not wanting, altho' this *Apothesis* be extremely small; this particularity doth likewise shew that there is no reason to think that agents do perform such and such actions because they are found with organs proper thereunto; for according to these philosophers *Apes* should speak, seeing that they have all the instruments necessary for speech; all this is confirmed and approved by the learned and accurate Dr. *Tyson* in his anatomy of the *Orang-Outrang* or *Pigmy*, he finding in the animal he described (which was of the *Ape-kind*) the whole structure of the *Larynx* and *Os Hyoidis* exactly as it is in man; and the reflection which the *Parisians* make upon their observation of these and neighbouring parts, he thinks very just and valuable; and adds farther, that this is not the only instance which may justify such an inference, tho' he thinks it so strong an one as the *Atheists* can never answer.

It is farther considerable, and adds to the weight of

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of this instance, that tho' birds have been taught to imitate human voice, and to pronounce words, yea, sentences; yet quadrupeds never, tho' they have organs far more fit for that purpose, and some of them, *viz. Dogs and Horses*, converse almost perpetually with men; and others, as *Apes*, are given naturally to imitate mens actions, as if providence had designed purposely to confute this fond conceit of the *Atheists*, by denying them the power to make use of these organs of speech, which, whether they understand what they said or not, they otherwise might and would have done in imitation of man, and that to greater perfection than birds do, or are capable of doing.

Farther, To prove that those *nobler faculties* of the soul, *Reason and Understanding*, cannot be produced by matter organized, but must have a higher principle, \* he thus argues: It is an observation of *Vesalius's*, that the brain of man, in respect of his body, is much larger than what is to be met with in any other animals, exceeding in bigness three oxes brains: whence he infers, that as animals excel in the largeness of the brain, so they do likewise in the principal faculties of the soul; which inference the Dr. cannot allow.

Dr. Tyson.

It is (saith he) a general received opinion, that the brain is the immediate seat of the soul itself; whence one would be apt to think, that seeing there is so great a disparity between the soul of a *Man* and a *Brute*, the organ in which it is placed should be very different too; yet, by comparing the brain of our *Pigmy* [the *Orang-Outrang*, or *wild Man*] with that of a *Man*, and with the greatest exactness observing each part in both, it was very surprizing to me to find so great a resemblance of the one to the other, as nothing could be more; and that in proportion to its body its brain was also as large as a *Man's*.

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Since therefore (he proceeds) the brain of our *Pigmy* doth in all respects so exactly resemble a man's, I might here make the same reflection the *Parisians* did upon the *Organs of Speech*, that there is no reason to think that agents do perform such and such actions because they are found with *Organs* proper thereunto; for then our *Pigmy* might be really a *Man*; the *Organs* in *animal* bodies are only a regular compages of pipes and vessels for the *Fluids* to pass thro', and are passive; what actuates them are the *Humours* and *Fluids*, and *animal life* consists in their due and regular motion in this *organical* body; but those *nobler faculties* in the mind of man must certainly have a higher principle, or *matter Organized* could never produce them; for why else, where the *Organ* is the same, should not the *Action* be the same too?

Object. *Some may here object and argue: If the body of man be thus perfect, why did God make any other animals? For the most perfect Being, the best, an infinitely good Agent, which wants neither wisdom nor power, should (one would think) only produce the most perfect.*

Ans. To which I answer: 1. That according to this argumentation one might infer, that God must produce but one kind of creature, and that the most perfect that he is able, which is impossible; for he being infinite in all perfection, cannot act *ad extremum virium*; unless he could produce an infinite creature, that is, another God, which is a contradiction; but whatever he makes must want degrees of infinite perfection, of which he could still (if he pleased) add more and more to it.

2. The inferior creatures are perfect in their order and degree, wanting no quality or perfection that is necessary or due to their nature and condition, their place and manner of living; now, why God might not make several subordinate

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ranks and degrees of creatures, they being good, I see no reason.

3. These several ranks and degrees of creatures are subservient one to another, and the most of them serviceable, and all some way or other useful to man; so that he could not well have been without them.

4. God made these several orders and degrees and in each degree so many varieties of creatures, for the manifestation and displaying of his infinite power and wisdom; for we have shewn before by a familiar instance, that there is more art and wisdom shewn in contriving and forming a multitude of different kinds of engines than in one only.

5. Yet I do not think that he made all these creatures to no other end but to be serviceable to man, but also to partake themselves of his overflowing goodness, and to enjoy their own beings. If we admit all other creatures in this inferior world besides man to be mere machines or *Automata*, to have no life, no sense nor perception of any thing, then I confess this reason is out of doors, for being incapable of pleasure or pain they can have no enjoyment; upon this account also, among others, I am less inclinable to that opinion.

I should now proceed to answer some objections which might be made against the wisdom and goodness of God in the contrivance and governance of the world, and all creatures therein contained; but that is too great and difficult a task for my weakness, and would take up more time than I have at present to spare were I qualified for it, and besides swell this volume to too great a bulk; only I shall say something to one particular which was suggested to me by a learned and pious \* friend.

Object. *A wise agent acts for ends. Now what end can there be of creating such a vast multitude of*

\* Mr. Robert  
Burscough of  
Totness, in  
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of insects as the world is filled with, most of which seem to be useless, and some also noxious and pernicious to man and other creatures?

*Answ.* To this I shall answer: 1. As to the multitude of *Species* or kinds. 2. As to the number of *Individuals* in each kind.

*First*, As to the multitude of *Species* (which we must needs acknowledge to be exceeding great, they being not fewer, perchance more than twenty thousand.) I answer, there were so many made.

1. To manifest and display the riches of the power and wisdom of God, Psalm civ. 24. *The earth is full of thy riches, so is the great and wide Sea, wherein are things creeping innumerable, &c.* We should be apt to think too meanly of those attributes of our Creator, should we be able to come to an end of all his works, even in this sublunary world; and therefore I believe never any man yet did, never any man shall so long as the world endures, by his utmost industry attain to the knowledge of all the *Species* of nature; hitherto we have been so far from it, that in vegetables the number of those which have been discovered this last age hath far exceeded that of all those which were known before; so true is that we quoted before out of *Seneca*: *Pu-  
silla res est mundus, nisi in eo quod quærat omnis  
mundus habeat.* The world is so richly furnished and provided, that man need not fear want of employment should he live to the age of *Methuselah*, or ten times as long; but of this, having touched it already, I shall add no more.

2. Another reason why so many kinds of creatures were made, might be to exercise the contemplative faculty of man, which is in nothing so much pleased as in variety of objects; we soon grow weary of one study, and if all the objects of the world could be comprehended by us, we should with *Alexander* think the world too little for us, and grow weary of running in a round of seeing the

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the same things; new objects afford us great delight, especially if found out by our own industry. I remember *Clusius* saith of himself, "That upon the discovery of a new plant he did not less rejoice than if he had found a rich treasure." Thus God is pleased, by reserving things to be found out by our pains and industry, to provide us employment most delightful and agreeable to our natures and inclinations.

3. Many of these creatures may be useful to us whose uses are not yet discovered, but reserved for the generations to come, as the uses of some we now know are but of late invention, and were unknown to our forefathers; and this must needs be so, because, as I said before, the world is too great for any man or generation of men, by his or their utmost endeavours to discover and find out all its store and furniture, all its riches and treasures.

*Secondly*, As to the multitude of individuals in each kind of *Insect*; I answer,

1. It is designed to secure the continuance and perpetuity of the several species, which if they did not multiply exceedingly, scarce any of them could escape the ravine of so many enemies as continually assault and prey upon them, but would be in danger to be quite destroyed and lost out of the world.

2. This vast multitude of insects is useful to mankind, if not immediately, yet mediately. It cannot be denied that birds are of great use to us, their flesh affording us a good part of our food, and that the more delicate too, and their other parts physick, not excepting their very excrements; their feathers serve to stuff our beds and pillows, yielding us soft and warm lodging, which is no small convenience and comfort to us, especially in these northern parts of the world; some of them have also been always employed by military men in plumes, to adorn their crests, and

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render them formidable to their enemies; their wings and quills are made use of for writing-pens, and to brush and cleanse our rooms, and their furniture; besides, by their melodious accents they gratify our ears; by their beautiful shapes and colours they delight our eyes, being very ornamental to the world, and rendring the country, where the hedges and woods are full of them, very pleasant and chearly, which without them would be no less lonely and melancholy; not to mention the exercise, diversion and recreation which some of them give us.

Now insects supply land-birds with the chiefest part of their sustenance; some, as the entire *Genus* of *Swallows*, live wholly upon them, as I could easily make out did any man deny or doubt of it; and not *Swallows* alone, but also *Wood-peckers*, if not wholly, yet chiefly; and all other sorts of birds partly, especially in winter-time, as appears by dissecting their stomachs.

As for young birds which are brought up in the nest by the old, they are fed chiefly if not solely by insects; and therefore for the time when birds for the most part breed, in the spring, when there are multitudes of caterpillars to be found on all trees and hedges; moreover, it is very remarkable, that of many such birds as when grown up feed almost wholly upon grain, the young ones are nourished by insects; for example, *Pheasants* and *Partridges*, which were well known to be granivorous birds, the young live only or mostly upon ants eggs. Now birds, being of a hot nature, are very voracious creatures, and eat abundantly, and therefore there had need be an infinite number of insects produced for their sustenance. Neither do birds alone, but many sorts of fishes, feed upon insects, as is well known to anglers, who bait their hogs with them; nay, which is more strange, divers quadrupeds feed upon insects, and some live wholly

wholly upon ants, bears; the earth-worms, beetles,

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wholly upon them, as two sorts of *Tamundus* upon ants, which therefore are called in *English* ant-bears; the *Camelion* upon flies; the mole upon earth-worms; the *Badger* also lives chiefly upon beetles, worms, and other insects.

Here we may take notice by the way, that because so many creatures live upon ants and their eggs, providence hath so ordered it, that they should be the most numerous of any tribe of insects that we know.

Conformable to this particular is the reason my ingenious and inquisitive friend Mr. *Derham*, before remembred, hath given of the production of such innumerable multitudes of some aquatick insects.

I have often thought (saith he) that there was some more than ordinary use in the creation for such insects as are vastly numerous, such as the *Pulices aquatici*, which are in such swarms as to discolour the waters, and many others; and therefore I have bent my enquires to find out the uses of such creatures, wherein I have so far succeeded, as to discover, that those vastly small *Animalcula*, not to be seen without a microscope, with which the waters are replete, serve for food to some others of the small insects of the water, particularly to the *Nympha Culicaria* [*Hirsuta* it may be called] figured in *Swammerdam*; for viewing that *Nympha* one day, to observe the motion of its mouth, and for what purpose it is in such continual motion, whether as fish to get air, or to suck in food, or both, I could plainly perceive the creature to suck in many of the most minute *Animalcula*, that were swimming briskly about in the water; neither yet do these *Animalcules* serve only for food to such *Nymphæ*, but also to another, to me anonymous insect of the waters, of a dark colour, cleft as it were asunder, and scarce so big as the smallest pin's head; these insects hunt these *Animalcules*,



and other small creatures that occur in the water, and devour them; and I am apt to think, altho' I have not yet seen it, that the *Pulex aquaticus arborescens* liveth upon these, or more minute and tender *Animalcules*, and that it is to catch them that it so leaps in the water.

This to me seems a wonderful work of God, to provide for the minutest creatures of the waters food proper for them, that is, minute and tender, and fit for their organs of swallowing.

As for noxious insects, why there should be so many of them produced, if it be demanded,

I answer, 1. That many that are noxious to us, are salutary to other creatures; and some that are poison to us, are food to them. So we see the poultry-kind feed upon *Spiders*; nay, there is scarce any noxious insect but one bird or other eats it, either for food or physick; for many, nay, most of those creatures whose bite or sting is poisonous, may safely be taken entire into the stomach; and therefore it is no wonder that not only the *Ibis* of *Egypt*, but even *Storks* and *Peacocks*, prey upon and destroy all sorts of *Serpents* as well as *Locusts* and *Caterpillars*.

2. Some of the most venomous and pernicious of insects afford us noble medicines, as *Scorpions*, *Spiders*, and *Cantharides*.

3. These insects seldom make use of their offensive weapons, unless assaulted or provoked in their own defence, or to revenge an injury; let them but alone, and annoy them not, nor disturb their young, and, unless accidentally, you shall seldom suffer by them.

Lastly, God is pleased sometimes to make use of them as scourges, to chastise or punish wicked persons or nations, as he did *Herod* and the *Egyptians*; no creature so mean and contemptible, but God can when he pleases produce such armies of them, as no human force is able to conquer or destroy,

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stroy, but they shall of a sudden consume and devour up all the fruits of the earth, and whatever might serve for the sustenance of man, as *Locusts* have often been observed to do.

Did these creatures serve for no other use, as they do many, yet those that make them an objection against the wisdom of God, may (as Dr. *Cockburn* well notes) as well upbraid the prudence and policy of a state for keeping forces, which generally are made up of very rude and insolent people, which yet are necessary, either to suppress rebellions, or punish rebels, and other disorderly and vicious persons, and keep the world in quiet.

From that part of this discourse which relates to the body of man, I shall make these practical inferences.

*Infer. 1. First,* Let us give thanks to Almighty God for the perfection and integrity of our bodies; it would not be amiss to put it into the eucharistical part of our daily devotions: We praise thee, O God, for the due number, shape, and use of our limbs and senses; and in general, of all the parts of our bodies; we bless thee for the sound and healthful constitution of them, Psalm c. *It is thou that hast made us, and not we ourselves; in thy book were all our members written.* The formation of the body is the work of God, and the whole process thereof attributed to him, Ps. cxxxix. 13, 14, 15. The mother that bears the child in her womb is not conscious to any thing that is done there, she understands no more how the infant is formed than itself doth; but if God hath bestowed upon us any peculiar gift or endowment wherein we excel others, as strength, or beauty, or activity, we ought to give him special thanks for it; but not to think the better of ourselves therefore, or despise them that want it.

Now because these bodily perfections being common blessings, we are apt not at all to consider

them, or not to set a just value on them; and because the worth of things is best discerned by their want, it would be useful sometimes to imagine or suppose ourselves, by some accident, to be deprived of one of our limbs or senses, as a hand, or a foot, or an eye, for then we cannot but be sensible that we should be in worse condition than now we are, and that we should soon find a difference between two hands and one hand, two eyes and one eye, and that two excel one as much in worth as they do in number; and yet if we could spare the use of the lost part, the deformity and unsightliness of such a defect in the body would alone be very grievous to us. Again, which is less, suppose we only that our bodies want of their just magnitude, or that they or any of our members are crooked or distorted; or disproportionate to the rest, either in excess or defect; nay, which is least of all, that the due motion of any one part be perverted, as, but of the eye in squinting, the eye-lids in twinkling, the tongue in stammering, these things are such blemishes and offences to us, by making us gazing-flocks to others, and objects of their scorn or derision, that we could be content to part with a good part of our estates to repair such defects or heal such infirmities. These things considered, and duly weighed, would surely be a great and effectual motive to excite in us gratitude for this integrity of our bodies, and to esteem it no small blessing. I say, a blessing and favour of God to us; for some there be that want it, and why might not we have been of that number? God was no way obliged to bestow it upon us.

And as we are to give thanks for the integrity of our body, so are we likewise for the health of it, and sound temper and constitution of all its parts and humours; health being the principal blessing of this life, without which we cannot enjoy or take comfort in any thing beside.

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Neither are we to give thanks alone for the first collation of these benefits, but also for their preservation and continuance. God preserves our souls in life, and defends us from dangers and sad accidents, which do so beset us on every side, that the greatest circumspection in the world could not secure us, did not his good providence continually watch over us; we may be said to walk and converse in the midst of snares; besides, did we but duly consider the make and frame of our bodies, what a multitude of minute parts and vessels there are in them, and how an obstruction in one redounds to the prejudice of the whole, we could not but wonder how so curious an engine as man's body could be kept in tune one hour as we use it, much less hold out so many years; how it were possible it should endure such hardships, such blows, so many shocks and concussions, nay, such violences and outrages as are offered it by our frequent excesses, and not be disordered and rendered useless; and acknowledge the transcendent art and skill of him who so put it together, as to render it thus firm and durable.

*Infer. 2. Secondly,* Have a care thou dost not by any vicious practice deface, marr, or destroy the workmanship of God; so use this body as to preserve the form and comeliness, the health and vigor of it.

1. For the form and beauty of the body, which mankind generally is fond enough of, and which must be acknowledged to be a natural endowment and blessing of God, a thing desirable, which all men take complacency in, which renders persons gracious and acceptable in the eyes of others; of which yet we do not observe that brute beasts take any notice at all: Of this I shall observe, that outward beauty is a sign of inward; and that handsome persons are naturally well inclined, till they do either debauch themselves, or are corrupted by

others, and then with their manners they mar their beauty too; for a man may observe, and easily discern, that as persons are better or worse inclined, the very air of their visage will alter much; and that vicious courses, *defacing the in-*

ward pulchritude of the soul, do change  
•Dr. More. even the outward countenance into an

abhorred hue\*; as is evident in the vices of intemperance and anger, as may, by sagacious persons, be observed in others also. No better Cosmeticks than a severe temperance and purity, a real and unaffected modesty and humility, a gracious temper and calmness of spirit, a sincere and universal charity; no true beauty without the signatures of these graces in the very countenance; they therefore who thro' the contrary vices do deface and blot out this natural character and impress, and do violence to their own inclination, that sacrifice this jewel to their lusts, that reject this gift of God, and undervalue the favour of man, aggravate their sin and misery, and purchase hell at somewhat a dearer rate than others do; and those that have but a mean portion of this gift, are the more obliged by virtuous practices, not only to preserve, but to improve it. Virtue (as *Cicero* observes) if it could be seen with corporeal eyes, *admirabiles sui amoras excitaret; it would excite a wonderful love of itself*. By the signatures it there impresses, it is in some measure visible in the faces of those that practise it, and so must needs impart a beauty and amiableness to them

*Diogenes Laertius* in the life of *Socrates*, tells us, that the philosopher was wont to advise young men, συνεχίς αὐτοπρίξασθαι, often to behold themselves in their looking glasses or mirrors. Grammercy, *Socrates*, that is good counsel indeed! will our young gentlemen and ladies be ready to say: We like it very well, and we practise accordingly: And it seems we are injuriously taxed and

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and reprehended by divines for spending so much time between a comb and a glass. Be not over-hasty, take what remains along with you: Mark the end for which the philosopher exhorts this, *ἵνα εἰ μὲν καλοὶ ᾖεν, ἀξιοὶ γίγνωντο, εἰ δ' αἰσχροὶ παιδεῖα τὸν δούλοισιν ἐπικαλύπτειν*, *That if they be handsome they might approve themselves worthy of their form; but if they be otherwise, they may by discipline and institution hide their deformity*; and so by their virtuous behaviour compensate the hardness of their favour, and by the pulchritude of their souls make up what is wanting in the beauty of their bodies; and truly I believe a virtuous soul hath influence upon its vehicle, and adds a lustre even to the outward man, shining forth in the very face.

2. So use the body as to preserve the health and vigor, and consequently prolong the life of it; these are things that all men covet; no more effectual means for the maintenance and preservation of them than a regular and virtuous life. That health is impaired by vice, daily experience sufficiently evinceth; I need not spend time to prove what no man doth or can deny. And as for length of days, we find by the same experience, that intemperate and disorderly persons are, for the most part, short-lived; moreover, immoderate cares and anxiety are observed suddenly to bring grey hairs upon men, which are usually the signs and forerunners of death; and therefore the way to live long must needs be in all points to use our bodies so as is most agreeable to the rules of temperance, and purity, and right reason; every violence offered to it weakens and impairs it, and renders it less durable and lasting. One means there is which physicians take notice of as very effectual for the preservation of health, which I cannot here omit, that is, a quiet and chearful mind, not afflicted with violent passions, or distracted with immoderate cares, for these have a great and ill influence



fluence upon the body; now, how a man can have a quiet and chearful mind under a great burden and load of guilt, I know not, unless he be very ignorant, or have a seared conscience; it concerns us therefore, even upon this account, to be careful of our conversation, and to keep our consciences void of offence both toward God and toward men.

*Infer.* 3. *Thirdly*, Did God make the body? let him have the service of it, *Rom. xii. 1.* *I beseech you, brethren, by the mercies of God, that you present your bodies a living sacrifice, holy, acceptable unto God, which is your reasonable service.* How we should do that, *St. Chrysostom* tells us in his commentary upon this place, *Μηδὲν ὀφθαλμος πονηρὸν βλέπει, ὃ γίγνεται ἁγία· μηδὲν ἡ γλῶσσα λαλεῖται αἰσχρὸν, ὃ γίγνεται προσφορά· μηδὲν ἡ χεὶρ πράττει παράνομον, ὃ γίγνεται εὐχαρίστημα*, *Let the eye behold no evil thing, and it is made a sacrifice; let the tongue speak no filthy word, and it becomes an oblation; let the hand do no unlawful action, and you render it a holocaust.* Yet it is not enough thus to restrain them from evil, but they must also be employed and exercised in doing that which is good; the hand in giving alms, the tongue in blessing them that curse us and despitefully use us; the ear in hearkening to divine lectures and discourses. *1 Cor. vi. 20.* *Glorify God in your body, or with your body, and in your spirit, which are God's;* and that not by redemption only, of which the apostle there speaks, but by creation also: *Rom. vi. 13.* *Neither yield ye your members as instruments of unrighteousness unto sin, but as instruments of righteousness unto God.* And again, *ver. 19.* *Even so now yield your members servants of righteousness unto holiness.* I shall instance in two members, which are especially to be guarded and restrained from evil, and employed in the service of God.

*First*, The eye. We must turn away our eyes from beholding vanity, as *David* prayed God would

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would his, *Psal. cxix. 37.* We must make a Covenant with our eyes, as *Job* did, *Job xxxi. 1.* These are the windows that let in exterior objects to the soul; by these the heart is affected; this way sin entred first into the world; our first parent saw that *the tree and its fruit was pleasant to the eyes*, and so was invited to take and eat it. There are four sins especially for which the eye is noted, as either discovering themselves in the eye, or whose temptations enter in by, and so give denomination to the eye.

1. There is a proud eye, *Prov. xxx. 13.* *There is a generation, O how lofty are their eyes! And their eye-lids are lifted up.* Chap. vi. :7. A proud look is reckoned the first of these six things that God hates, *Psal. xviii. 27.* God (the Psalmist saith) will bring down proud or high looks. *Psal. ci. 5.* *Him that hath a high look and a proud heart (saith David) I will not suffer.* And in *Psal. cxxxix. 1.* he saith of himself, that *his heart is not haughty, nor his eyes lofty.* By which places it appeareth that pride sheweth forth itself in the eyes especially and that they are as it were the seat or throne of it.

There is a wanton eye, which the prophet *Isaiah* speaks of in his third chapter at the 16th verse, *because the daughters of Jerusalem walk with stretched-out necks and wanton eyes.* The apostle *Peter*, in his second epistle, Chap. ii. 24. mentions *eyes full of adultery*; for by these casements enter in such objects as may provoke and stir up adulterous thoughts in the mind, as they did in *David's*; and likewise impure thoughts conceived in the heart, may discover themselves by the motions of the eye; and therefore in this respect we should do well with holy *Job*, to make a covenant with our eyes, and not to gaze upon any object which may tempt us to any inordinate appetite and desire: for our Saviour tells us, it were better to pluck out our right eye than that it should

be.

be an offence to us; which I suppose refers to this matter, because it immediately follows these words, *He that looketh upon a woman to lust after her, hath already committed adultery with her in his heart.*

3. There is a *covetous eye*. By covetousness I understand not only a desiring what is another man's, which is forbidden in the Tenth Commandment, but also an inordinate desire of riches, which the apostle *John* seems to understand in his first epistle, Chap. ii. 16. *by the lust of the eye.* And covetousness may well be called *the lust of the eye*, because 1. The temptation or tempting object enters by the eye; so the seeing the wedge of gold and *Babylonish* garment stirred up the covetous desire in *Achan*. 2. Because all the fruit a man reaps of riches, more than will furnish his necessities and conveniences, is the feeding of his eye, or the pleasure he takes in the beholding of them. *Eccl. v. ii. When goods increase, &c. what good is there to the owners thereof, saving the beholding them with their eyes?*

There is an *envious eye*, which by our Saviour is called an evil eye, *Matth. xx. 15. Is thine eye evil because I am good?* That is, enimest thou thy brother because I am kind to him? And *Chap. vii. 22.* one of those evil things which proceed out of the heart and defile a man, is *an evil eye*. Envy is a repining at the prosperity or good of another, or anger and displeasure at any good of another which we want, or any advantage another hath above us; as in the parable of the labourers in the vineyard, those that came in first envied the last, not because they received more than they, but because they received equal wages for less time; those that are subject to this vice cannot endure to see another man thrive, and are apt to think his condition better than theirs, when indeed it is not.

Let us then so govern our eyes that we discover by them none of these vices; yet the humility  
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and purity looks; let us have a care of our words, that they be pure, on, nor let us emulosity, and other things, and viewing a thing, that of the information let us take effects of others, pious issues of able affection those sacrifices to ration; weeping but especially

*Secondly* the tongue, speech, exercise, need of once he this object in the heart do very shall not that the curbed bridle, apostle tongue



and purity of our minds appear even in our outward looks; let neither pride nor lust manifest themselves in the posture or motion of our eyes; let us have a care that these members be neither the inlets or outlets of any of the fore-mentioned vices, that they neither give admission to the temptation, nor be expressive of the conception of them; let us employ them in reading the word of God and other books, for the increase of our knowledge, and direction of our practise; in diligently viewing and contemplating the works of the creation, that we may discern and admire the footsteps of the divine wisdom, easily to be traced in the formation, disposition, and designations of them; let us take notice of any extraordinary events and effects of God's providence towards ourselves or others, personal or national, that as they are the issues of his mercy or justice, they may stir up suitable affections in us of thankfulness or fear; let those sad and miserable objects that present themselves to our sight move us to pity and commiseration; and let our eyes sometimes be exercised in weeping for the miseries and calamities of others, but especially for our own and their sins.

*Secondly*, Another member I shall mention is, the *tongue*, which as it is the chief instrument of speech, so it may be well or ill employed in the exercise of that action, and therefore stands in need of direction and restraint. I remember I once heard from ingenious *Anatomists of Padua* this observation, That there are but two members in the body that hath a natural bridle, both which do very much need it, the tongue, and another I shall not name; the signification whereof may be, that they are not to be let loose, but diligently curbed and held in. That the tongue needs a bridle, you will readily grant, if you read what the apostle *James* hath written of it, Chap. iii. 6. *The tongue is a fire, a world of iniquity: So is the tongue*

*tongue among our members, that it defileth the whole body, and setteth on fire the course of nature, and is set on fire of hell. For every kind of beasts, and of birds, and of serpents, and of things in the sea, is tamed, and hath been tamed of mankind; but the tongue can no man tame, it is an unruly evil, full of deadly poison.* For the better government of the tongue, I shall note some vices of speech which must carefully be avoided; first of all, *loquacity* or *garrulity*; this the contrivance of our mouths suggests to us; our tongues are fenced and guarded with a double wall or mound of lips and teeth, that our words might not rashly or unadvisedly slip out; then nature hath furnished us with two ears and but one tongue, to intimate that we must hear twice so much as we speak. Why *loquacity* is to be avoided, the wise man gives us a sufficient reason, *Prov. x. 19. In the multitude of words there wanteth not sin.* And, *Eccl. v. 7. In many words there are diverse vanities.* To which we may add another of great force with most men, *viz. that it hath been always esteemed an effect and argument of folly, Eccl. v. 3. A fool's voice is known by multitude of words.* And on the contrary, to be of few words is a sign of wisdom; and he that is wise enough to be silent, tho' a fool, may pass undiscovered. Besides all this, a talkative person must needs be impertinent, and speak many ill words, and so render himself burdensome and odious to company, and may perchance run himself upon great inconveniences, by blabbing out his own or others secrets; for a word once uttered,

*fuit irrevocabile, \* is irrevocable,*

\* *Run before the Understanding or Wit.*

whatever the consequence of it be; great need have we therefore *to set a watch over our mouths, and to keep the door of our lips,* Psalm

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cxli. 3. and not suffer our tongues προτρεχον της διανοιας, as *Isocrates* phraseth it.

Secondly, Lying or false speaking. There is difference between *mentiri*, and *mendacium dicere*, that is, lying, and speaking of an untruth, or a thing that is false: *Mentiri*, is *contra Mentem ire*, which, though it be no good Etymology of the word, is a good notion of the thing; that is, to go against one's mind or speak what one does not think.

Ἐτερον μὲν κεύθειν ἐνὶ φρεσίν, ἄλλο δὲ βάζειν.

As *Homer* expresses it, 'to conceal one thing in the mind, and speak another with the tongue;' hence a man may speak an untruth and yet not lie, when he *thinks* he speaks the truth; and on the contrary, may speak what is materially true and yet lie, when he speaks what he thinks not to be true. The tongue was made to be the *Index* of the mind, speech the interpreter of thought, therefore there ought to be a perfect harmony and agreement between these two; so that lying is a great abuse of speech, and a perverting the very end of it, which was to communicate our thoughts one to another; it hath also an ill principle for the most part, proceeding either from *baseness of spirit*, or *Cowardice*, as in them that have committed a fault, and deny it for fear of punishment or rebuke; and therefore the antient *Persians*, as *Xenophon* tells us in his *Κύρου παιδεία* made it one of the three things they diligently taught their children, which were *ἱππεύειν, ἔτοξεύειν, ἔαληθεύειν* to ride, to shoot, and to speak the truth: Or from *covetousness*, as in tradesmen, who falsely commend their commodities, that they may vend them for a greater price; or from *vanity* and *vain-glory*, in them who falsely boast of any quality or action of their own. It is odious both to God and man;



to God, *Prov. vi. 17.* *A lying tongue is one of those six or seven things that are an abomination to him; to men, as Homer witnesseth in the verse preceeding the fore-quoted.*

Ἐχθρὸς γὰρ μοι κείνος ὅμως Αἰδωο πύλῃσι, &c.

‘He that tells lies is as hateful to me as the gates of hell and death.’—The practice of lying is a diabolical exercise, and they that use it are the devil’s children, as our Saviour tells us, *John viii. 24.* *Ye are of your father the devil, &c. for he is a liar, and the father of it.* And, lastly, it is a sin that excludes out of heaven, and depresses the soul into hell, *Rev. xxi. 8.* *All liars shall have their part in the lake which burns with fire and brimstone, which is the second death.*

Thirdly, Another vice, or abuse of speech, or vicious action, to which the tongue is instrumental, is *slandering*; that is, raising a false report of any man, tending to his defamation; this might have been comprehended under the former head, being but a kind of lying, proceeding from enmity or ill-will; it is a very great injury to our neighbour, mens reputations being as dear to them as life itself; so that it is grown to be a proverb among the vulgar, *Take away my good name, and take away my life.* And that which enhances this injury is, that it is irreparable; we cannot by any contrary declaration, so clear the innocency of our neighbour, as wholly to extirpate the pre-conceived opinion out of the minds of those to whom our confession comes; and many will remain whom the calumny hath reached, to whom the vindication probably will not extend, the pravity of man’s nature being more apt to spread and divulge an ill report than to stop and silence it. I might instance in the flattering of others and boasting of ourselves, for two abuses of speech, but they may

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both be referred to lying, the one to please others, and puff them up with self-conceit, and a false opinion, that they have some excellent quality or endowment, which they want, or have not in such a degree, or that they are better thought of by others than indeed they are, and more honoured; the other, to gain more honour than is due to ourselves. Neither yet is boasting only of what we have not, but also of what we have, condemned and disallowed by God and men, as being contrary to that humility and modesty that ought to be in us, *Prov. xxvii. 2. Let another man praise thee, and not thine own mouth, a stranger, and not thine own lips.* And moralists proceed so far as to censure all unnecessary *παραυτολογία*, that is, talking of a man's self.

*Fourthly*, Obscene and impure words are another vicious effect of the tongue; those are principally the *σαπροὶ λόγοι*, rotten speeches the apostle speaks of, *Eph. v. 29.* such as chaste ears abhor, which tend only to the depraving and corrupting the hearers, and are to be studiously and carefully avoided by all that pretend to christianity, *Eph. v. 3. But fornication and all uncleanness, let it not be once named among you.*

*Fifthly*, Cursing and railing or reviling words, are also a great abuse of speech, and outrageous effects and expressions of malice and wickedness, *Psal. x. 7.* The *Psalmist* makes it part of the character of a wicked man, that *his mouth is full of cursing*; which passage we have quoted by the apostle, *Rom. iii. 14. whose mouth is full of cursing, and bitterness.*

*Sixthly*, Swearing, and irreverently using the name of God in common discourse and converse, is another abuse of the tongue; to which I might add, vehement asseverations upon slight and trivial occasions. I do not deny, but in a matter of weight and moment, which will bear out such

attestation, and where belief will not be obtained without them, and yet it may much import the hearer or speaker that his words be believed, or where the hearer would not otherwise think the matter so momentuous or important as indeed it is, protestations and asseverations, yea, oaths, may lawfully be used; but to call God to witness to an untruth or a lie perhaps, or to appeal to him on every trivial occasion in common discourse, customarily, without any consideration of what we say, is one of the highest indignities and affronts that can be offered him, being a sin to which there is no temptation; for it is so far from gaining belief (which is the only thing that can with any shew of reason be pleaded for it) that it rather creates diffidence and distrust; for as *multa fidem promissa levant*, so *multa juramenta* too; it being become a proverb, *He that will swear will lie*; and good reason there is for it, for he that scruples not the breach of one of God's commands, is not likely to make conscience of the violation of another.

*Lastly*, (for I will name no more) Scurrilous words, scoffing and jeering, flouting and taunting, are to be censured as vicious abuses of speech.

This scoffing and derision proceeds from contempt; and that of all injuries men do most impatiently bear; nothing offends more or wounds deeper: and therefore what greater violation of that general rule of christian practice, *to do to others as we would they should do unto us*? This injury of being derided the *Psalmist* himself complains of, *Psal. lxxix. 11, 12. I became a proverb to them. They that sit in the gate speak against me, and I was the song of the drunkards.* And *Psal. xxxv. 15.* according to the church translation, *The very abjects came together against me unawares, making mows at me, and ceased not.* And the prophet *Jeremy, Jer. xx. 7. I am in derision daily, every one mocketh me.* And tho' there may be some wit shewn in scoffing

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sing and jesting upon others, yet it is a practice inconsistent with true wisdom. The scorner and the wise man are frequently opposed in scripture, *Prov. ix. 8. and Chap. xiii. 1. &c.* It is a proverbial saying, *The greatest clerks are not always the wisest men.* I think the saying might as often be verified of the greatest wits. Scorning, in that gradation in the first *Psalms*, is set down as the highest step of wickedness. And *Solomon* tells us, *that judgments are prepared for the scornors.*

You will say to me, how then must our tongues be employed? I answer, 1. In praises and thanksgiving unto God; *Psal. xxxv. 28. And my tongue shall speak of thy righteousness and of thy praises all the day long.* Parallel whereto is *ver. 24. of Psal. lxxi.* indeed the book of *Psalms* is in a great measure but an exercise of or exhortation to this duty. 2. We must exercise our tongues in talking of all his wonderful works: *Psalms cxlv. 5, 6. I will speak of the glorious honour of thy majesty and of thy wondrous works.* 3. In prayer to God. 4. In confession of him and his religion, and publicly owning it before men whatever the hazard be. 5. In teaching, instructing, and counselling of others. 6. In exhorting them. 7. In comforting them that need it. 8. In reproving them. All which particulars I might enlarge upon, but because they come in here only as they refer to the tongue, it may suffice to have mentioned them summarily.

Thirdly, Let us hence learn duly to prize and value our souls. Is the body such a rare piece, what then is the soul? The body is but the husk or shell, the soul is the kernel; the body is but the cask, the soul is the precious liquor contained in it; the body is but the cabinet, the soul the jewel; the body is but the ship or vessel, the soul the pilot; the body is but the tabernacle, and a poor clay tabernacle or cottage too, the soul the inhabitant; the body is but the machine or engine,

the soul that *ἐνδύει* τὴν, that actuates and quickens it; the body is but the dark lantern, the soul or spirit is the candle of the Lord that burns in it: And seeing there is such difference between the soul and the body in respect of excellency, surely our better part challenges our greatest care and diligence to make provision for it. Bodily provision is but half provision, it is but for one part of a man, and that the meaner and more ignoble too, if we consider only the time of this life; but if we consider a future state of endless duration after this life, then bodily provision will appear to be, I do not say, quarter provision, but no provision at all in comparison, there being no proportion between so short a period of time and the infinite ages of eternity; let us not then be so foolish as to employ all our thoughts and bestow all our time and pains about cherishing, accommodating and gratifying our bodies, in *making provision for the flesh to fulfill the lusts thereof*, as the apostle phraseth it, and suffer our souls to lie by neglected in a miserable, and poor, and blind, and naked condition. Some philosophers will not allow the body to be an essential part of man, but only the vessel or vehicle of the soul; *Anima cujusque est quisque; the soul is the man*. Tho' I would not be so unequal to it, yet I must needs acknowledge it to be but an inferior part; it is therefore so to be treated, so dieted and provided, as to render it most calm and compliant with the soul, most tractable and obsequious to the dictates of reason; not so pampered and indulged, as to encourage it to cast its rider, and to take the reins into its own hand, and usurp dominion over the better part, the *τὸ ὑπερβονικόν*, to sink and depress it into a sordid compliance with its own lusts, *Atque effigere humi divinæ particulam auræ*.

This is our duty; but alas! what is our practice?

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rice? Our great partiality towards our bodies, and neglect of our souls, shews clearly which part we prefer; we are careful enough of wounding or maiming our bodies, but we make bold to lash and wound our souls daily; for every sin we commit being contrary to its nature, is a real stripe, yea, a mortal wound to the soul; and we shall find it to be so, if our consciences be once awakened to feel the sting and smart of it. We are industrious enough to preserve our bodies from slavery and thralldom, but we make nothing of suffering our souls to be slaves and drudges to our lusts, and to live in the vilest bondage to the most degenerate of creatures, the devil. We are thrifty and provident enough, not to part with any thing that may be serviceable to our bodies under a good consideration, and we so esteem them as that we will part with all we have for the life of them; but we make little account of what is most beneficial to our souls, the means of grace and salvation, the word of God, and duties of his worship and service; nay, we can be content to sell our souls themselves for a trifle, for a thing of nothing, yea, for what is worse than nothing, the satisfying of an inordinate and unreasonable appetite or passion. We highly esteem and stand much upon our nobility, our birth and breeding, tho' we derive nothing from our ancestors but our bodies and corporeal qualities; and it is useful so far to value and improve this advantage, as to provoke us to imitate the good example of our progenitors, not to degenerate from them, nor to do any thing unworthy of our breeding; and yet the divine original of our souls, which are beams from the Father of lights, and the immediate off-spring of God himself, τὸ γὰρ ἡ γενεὴ τοῦ θεοῦ, hath little influence upon us to engage us to walk worthily of our extraction, and to do nothing that is base or ignoble, and unsuitable to the dignity of our birth.

You



You will say, how shall we manifest our care of our souls? What shall we do for them? I answer, the same we do for our bodies.

*First*, We feed our bodies, our souls are also to be fed; the food of the soul is knowledge, especially knowledge in the things of God, and the things that concern its eternal peace and happiness; the doctrine of christianity, the word of God read and preached, 1 Pet. ii. 2. *As new-born babes desire the sincere milk of the Word, that ye may grow thereby*, Heb. v. 12. The apostle speaks both of milk and of strong meat. Milk he there calls the principles of the doctrine of Christ. And again, 1 Cor. ii. 3. *I have fed you with milk, and not with meat; for hitherto you were not able to bear it*. So we see in the apostle's phrase, feeding of the flock, is teaching and instructing of them. Knowledge is the foundation of practice; it is impossible to do God's will before we know it; the word must be received into an honest and good heart, and understood, before any fruit can be brought forth.

*Secondly*, We heal and cure our bodies, when they are inwardly sick, or outwardly harmed: Sin is the sickness of the soul. Mat. ix. 12. *They that be whole need not a physician, but they that are sick*, saith our Saviour by way of similitude; which he explains in the next verse, *I am not come to call the righteous but sinners to repentance*. For the cure of this disease, an humble serious hearty repentance, is the only physick; not to expiate the guilt of it, but to qualify us to partake of the benefit of that atonement which our Saviour Christ hath made by the sacrifice of himself, and restore us to the favour of God, which we had forfeited, it being as much as in us lies, an undoing again what we have done.

*Thirdly*, We cloath and adorn our bodies; indeed too much time and too many thoughts we be-

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bestow upon that ; our souls also are to be cloathed with holy and virtuous habits, and adorned with good works. 1 Pet. v. 5. *Be ye cloathed with Humility.* And in the same epistle, Chap. ii. 2. he exhorts women *to adorn themselves, not with that outward adorning of plaiting the hair, and wearing of gold, &c. but with the ornament of a meek and quiet spirit, which is in the sight of God of great price :* And Rev. xix. 8. *The righteousness of the saints is called fine linen.* And the saints are said to be cloathed in *white raiment.* Mat. xxiii. 11. Works of righteousness and a conversation becoming the gospel is called a *Wedding-garment.* Col. iii. 10. *Put on the new man.* And again, *Put on therefore as the elect of God, bowels of mercy, meekness, &c.* On the contrary, vicious habits and sinful actions are compared to filthy garments. So, Zech. iii. 3. Joshua the high-priest is said to be *cloathed with filthy garments ;* which in the next verse are interpreted his iniquities, either personal, or of the people whom he represented: *I have caused thy iniquity to pass from thee, and will cloath thee with change of raiment.*

*Fourthly,* We arm and defend our bodies, and our souls have as much need of armour as they ; for the life of a christian is a continual warfare ; and we have potent and vigilant enemies to encounter withal, the devil, the world, and this corrupt flesh we carry about us ; we had need therefore to take to us the christian panoply, to *put on the whole armour of God, that we may withstand in the evil day, and having done all, may stand ; having our loins girt with truth, and having on the breast-plate of righteousness, and our feet shod with the preparation of the gospel of peace. Above all, taking the shield of faith ; and for an helmet, the hope of salvation, and the sword of the spirit, which is the word of God,* Eph. vi. 13, 14.

He that with this christian armour manfully  
fights

fights against and repels the temptations and assaults of his spiritual enemies; he that keeps his garments pure, and his conscience void of offence towards God and towards man, shall enjoy perfect peace here, and assurance for ever. *Tacitus* saith of the *Finni*, a northern people, that they were *securi adversus homines, securi adversus Deos*. They need not fear what God or man could do to them, because they were in as bad a condition as could consist with living in the world; they could not be banished into a worse country, nor put into worse circumstances than they were in already. I might say of the man that keeps a good conscience that he is secure against God and man; not in that sense the *Finni* were, but secure of any evil befalling him from either. God can do him no harm, not for want of power, but for want of will, which is regulated by his truth and justice. He is also secure in respect of men, because he is under the protection of the Almighty: and if any there be that would do him harm, they shall either be restrained by the divine providence, or if they be permitted to injure him, it shall tend only to the exercise and improvement of his faith and patience, and enhancing his future reward at that great day, when the Almighty shall dispense *Aureolæ* to those champions who have signalized their valour and fidelity by heroick actions, or patient sufferings of unworthy things for his sake. 3. A good conscience not only secures a man from God and men, but from himself too; *There is no peace to the wicked, saith my God*, no inward peace; such a man is at odds with himself; for the commandments of God being agreeable to the nature of man, and perfectly conformable to the dictates of right reason, man's judgment gives sentence with the divine law, and condemns him when he violates any of them; and so the sinner becomes an *Heautontimorumenos*, a tormenter of himself. *Prima*

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*ma est hæc ultio, quod se iudice nemo nocens absolvitur.* No guilty person is absolved at his own tribunal, himself being judge.

Neither let any profligate person, who hath bidden defiance to his conscience, and is at war with himself, think to take sanctuary in atheism, and because it imports him highly there should be no God, stoutly deny that there is any. For first, supposing that the existence of a Deity were not demonstrably or infallibly proved (as most certainly is) yet he cannot be sure of the contrary, that there is none. *For no man can be sure of a pure negative, namely, that such a thing is not, unless he will either pretend to have a certain knowledge of all things that are or may be, than which nothing can be more monstrously and ridiculously arrogant; or else unless he be sure that the being of what he denies doth imply a contradiction, for which there is not the least colour in this case; the true notion of God consisting in this, that he is a being of all possible perfection, that I may borrow my Lord Bishop of Chester's words, in his discourse of natural religion, Page 94.*

Now if he be not sure there is no Deity, he cannot be without some suspicion and fear that there may be one.

Secondly, *If there should be a Deity, so holy and just, and powerful, as is supposed, what vengeance and indignation may such vile miscreants and rebels expect, who have made it their business to banish him out of the world, who is the great Creator and governor of it; to undermine his Being, and eradicate all notions of him out of their own and other mens minds; to provoke his creatures and vassals to a contempt of him, a slighting of his fear and worship, as being such imaginary Chimaera's as are fit only to keep fools in awe? Certainly, as this is the highest provocation that any man can*  
he

324      *The Wisdom of GOD, &c.*      Part II.  
*be guilty of, so shall it be punished with the forest  
vengeance.*

Now a slender suspicion of the existence of a Being, the denial whereof is of so sad consequence, must needs disturb the Atheist's thoughts, and fill him with fears, and qualify and allay all his pleasures and enjoyments, and render him miserable even in his life.

*But on the other side, he that believes and owns a God, if there should be none, is in no danger of any bad consequent; for all the inconvenience of this belief will be, that he may be hereby occasioned to tie himself up to some needless restraints during this short time of our life, wherein notwithstanding there is, as to the present, much peace, quiet, and safety; as to the future, his error shall die with him, there being none to call him to an account for his mistake. Thus far the Bishop.*

To which I shall add, that he not only suffers no damage, but reaps a considerable benefit from this mistake; for, during this life he enjoys a pleasant dream or fancy of a future and blessed state, with the thoughts and expectations whereof he solaces himself and agreeably entertains his time, and is in no danger of being ever awakened out of it and convinced of his error and folly, death making a full end of him.

*F I N I S.*

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